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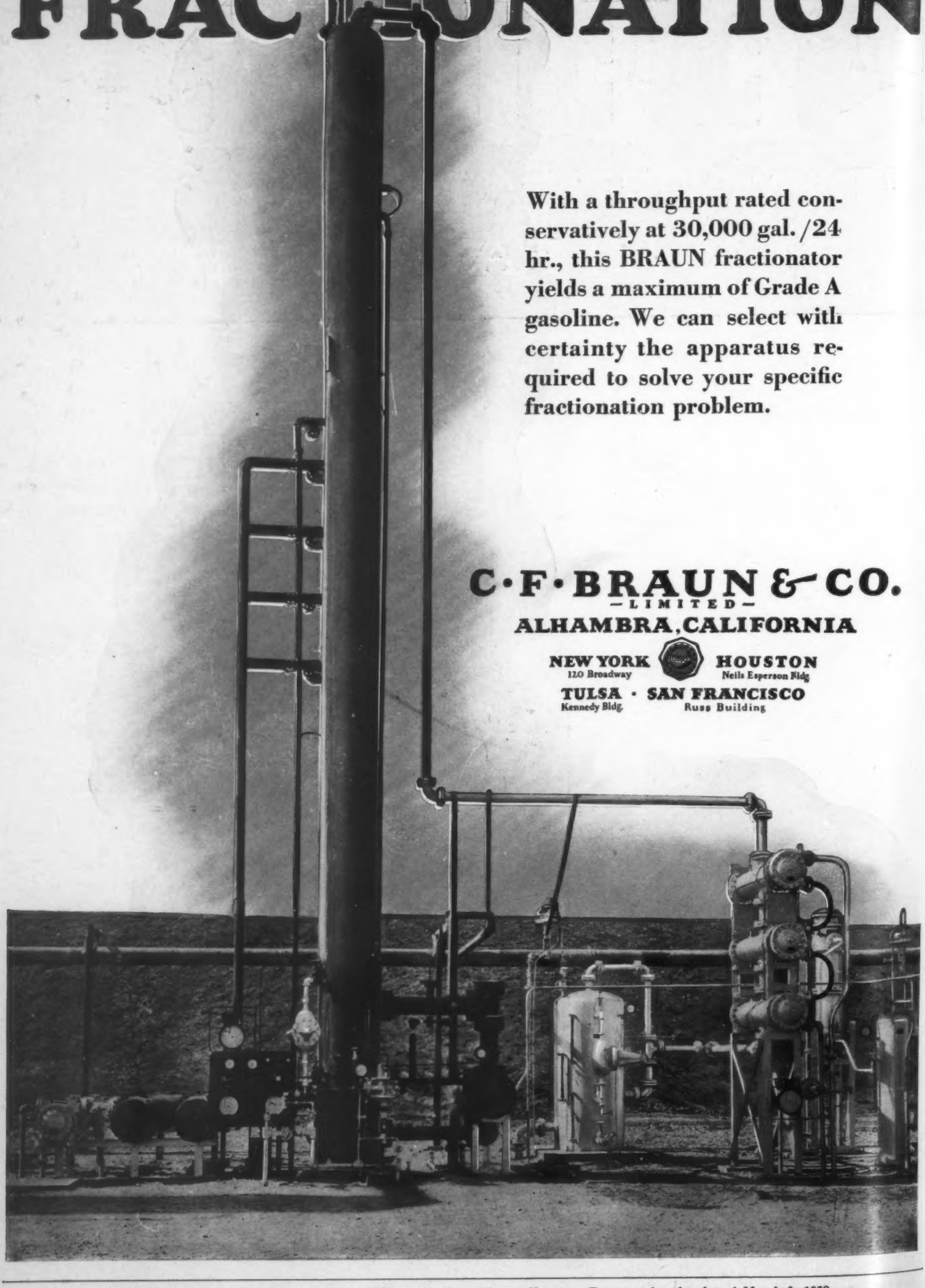

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GRADY TRIPLETT, *Editor*

GEORGE REID, *Associate Editor*

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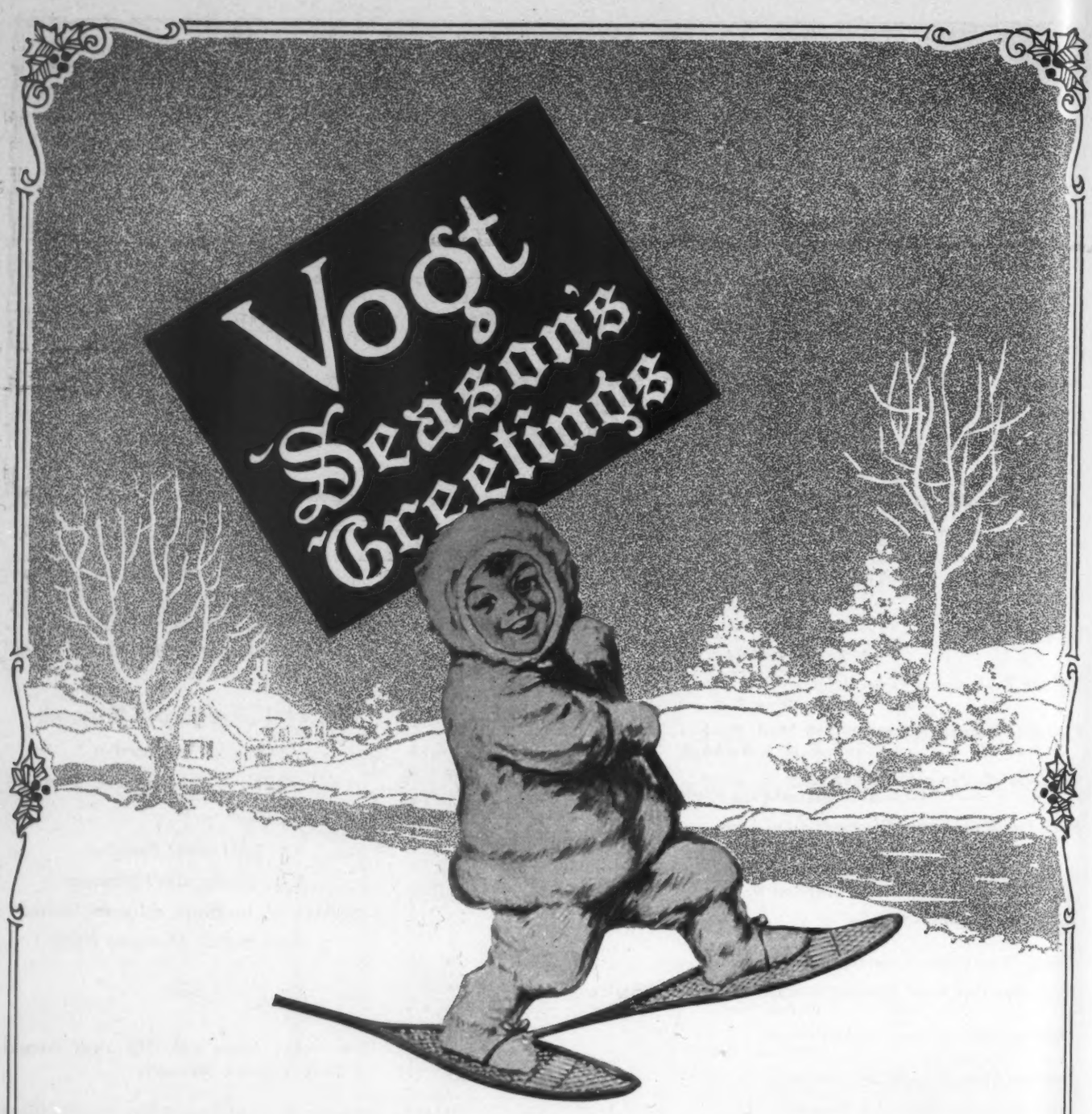

The Spirit Of The Season Prompts Us To Express To You Our Best Wishes For A Merry Christmas And A Happy, Prosperous New Year

Henry Vogt Machine Co.
Louisville, Kentucky.

It's a Long Job

WHAT the Petroleum Industry needs most today is to realize that its conservation efforts must extend over a long period. Instead of looking at curtailment as something for the month, it should be accepted as something essential for a year.

Credit is due the oil producers of Oklahoma, Texas and California for action which has saved a price structure from crude oil to gasoline. Still it should not be forgotten that lack of pipe lines in one area and a price cut in another brought about this restriction in well output.

But the alarming situation is how quickly a distressing situation is ignored. Both within the petroleum industry and in financial circles much is being said of the fact that crude oil output is now about equal to current consumption. There are even predictions that storage will be drawn on shortly.

It will be a blessing if crude oil storage is drawn on shortly, but it will be disaster if it brings increased drilling to the petroleum industry. Estimates are that the petroleum industry will colse this year with nearly 700-million barrels of crude oil in storage. It would be well if this could be cut in half.

As long as demand is balanced with output, the petroleum industry must bear the burden of this stupendous amount of raw material. It is not needed. It is unfortunate that the industry supports its greatest amount of stored raw material at a time when it has its greatest known reserve of material under ground.

The day that the pipe lines of the country begin drawing on storage will be an eventful one for the whole petroleum industry. But a far greater day will be the one, when present storage has been brought down below a half billion barrels.

The petroleum industry seems inclined to consider the first draft on storage as a signal for renewed activity of the drill, higher prices for crude oil and higher prices for refined products. This first draft on storage is but the start to correct a sad economic situation. Only lack of proper regard for facts can interpret it as the last step of correction.

It required more than 90 days for the petroleum industry to become involved in this mass of stored crude oil. And it is going to take more than 90 days for it to remove the burden. If crude oil output could be brought 100,000 barrels a day under current requirements, a whole year would not see storage figures at a desirable level. It would take almost three years of that to write 100-million barrels off the total of storage.

Any man who can picture a date when well output will be 100,000 barrels daily under current requirements is as much of an optimist as the man who now looks on the first draft on storage as a signal for unbridled development and higher prices.

It is not for any one division of the petroleum industry to bring about better economic conditions. But it is well for the refining division to realize that it stands in a strategic position in that regard. If stills are not overcrowded, there is not going to be any resumption of unnecessary field development, regardless of how rosy the skies may appear to some.

Grady Tijlett

Rarely is quality improved and cost decreased at the same time

This is fortunately true of Dubbs Cracked Gasoline compared with straight distilled gasoline, as every Dubbs Licensee knows

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
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Institute Realignment Gives Refining More Prominence at Sessions

By GEORGE REID
Associate Editor

WITH reorganization of the American Petroleum Institute to embrace three major departments, as approved by the action of the board of directors of the Institute at Chicago December 3, opportunity is provided for widening the scope of activity of the refinery engineering and technologist group. The American Petroleum Institute will function through the work of three major departments to be known as the division of production, division of refining, and division of marketing. This important move places the activities of the Institute parallel with the three major divisions of the petroleum industry.

With this realignment of Institute activities the departmentalized scheme of organization provides means whereby the activities directly related to refining, for example, may be more generally participated in by members directly interested in the manufacturing branch of the industry.

Through this action a separate forum is provided where Institute members, independently of other members differently engaged, may study those problems which are pertinent to their branch of the industry. Application of effort throughout this departmental plan will assist greatly in obtaining and maintaining better and closer cooperative relationships between those engaged in the same branch of the industry.

In the past, matters pertinent to refining problems, both engineering and technologic, have been confined to the activities of the general committee on refining technology, under the chairmanship of E. W. Isom. Mr. Isom has been earnestly and actively seeking more recognition from the Institute board of directors and the permanent establishment of a department of the Institute wherein the activities of the refinery technology group could be centered, assures that its scope of activities may be widened, the work greatly enlarged, and provision made for the establishment of a continuous program of endeavor. Refinery operators, engineers and technologists welcome the establishment of the department of refining, for it gives opportunity for an enlarged program and possibly confines such important activities to the membership of the American Petroleum Institute. Without such a department within the Institute, it is not improbable that the splendid work done by the committee on refinery technology during the past two years would have been dropped and the development of a petroleum technology division within some other organization or association would have been necessary. Under the present arrangement, research and development activities will be centered within the scope of work performed by the American Petroleum Institute, where it properly belongs.

PROVISION FOR CHAPTERS

It is tentatively proposed that appropriate regional, district, or chapter committees be appointed for the purpose of conducting periodical or semi-annual meetings of refinery groups. There shall be separate divisional membership open to all interested individual members of the Institute upon payment of an annual fee for each calendar year not to exceed $5.00, and an associate membership open to individuals not engaged actively in the petroleum industry—such as government employees and teachers, and the like, who may desire to associate themselves with any particular divisional activity.

The resolution states that there shall be 25 committeemen for each division, headed by a vice president of the Institute who will act as chairman. Some of the committeemen will be appointed by the Institute through the action of the board of directors. Others will be elected by the division membership. Work of the division will be in charge of the committee membership which will report directly to the board of directors of the Institute who will continue to have final authority in all matters pertaining to general policy.

During the past two years the best engineering information and technical data available for the industry has come out of the work done by the general committee on refinery technology and the programs sponsored and presented by this committee with the cooperation of members of the industry who so willingly have presented results of their investigations for discussion and comment and utilization by the refining branch of the industry. With such effort coordinated by departmental activities under the present allignment of the Institute it is confidently expected that the future will see even more valuable data accumulated, presented, and disseminated through such cooperative effort which will contribute much to the progress of refining and manufacture.

EXTRACT FROM PRESIDENT'S ADDRESS

President E. B. Reeser, in his address at the opening general session of the convention, detailed the activities of the Institute, endorsing cooperation as the cornerstone of power, stability, and progress. In commendation of the work done by the refinery

technology section, the report of the president states: "A general committee on refinery technology, composed of oil company technologists, handles such problems in this field as may be properly considered by the Institute and develops the program on refinery technology for our annual meetings. This year there are five group sessions dealing with this topic. During the year, the committee has cooperated with the federal specifications board in revising the federal specifications for motor fuel. The committee feels that the best interests of oil company refinery technologists would be advanced by the formation within the institute of a department of refinery technology.

METHODS OF TESTING

"The Institute has long maintained and continues its cooperation with committee D-2 on petroleum products and lubricants of the American Society for Testing Materials in developing standard methods of test for petroleum and petroleum products. Twenty-one standard methods pertaining to petroleum and its products have been developed by this committee. Acting on the recommendation of the general committee on refinery technology, the Institute has recently recognized the A.S.T.M. standard methods of testing developed by committee D-2 through their adoption as A.P.I. standards."

COOPERATIVE MOTOR FUEL RESEARCH

"The National Automobile Chamber of Commerce, the Society of Automotive Engineers, and the Institute have sponsored and financed cooperative research on motor fuel problems at the United States Bureau of Standards for several years. During 1929, the work has consisted largely of a study of volatility in its relation to starting and acceleration, and of progress toward the standardization of a method for determining the anti-knock ratings. Developments of the past year are to be reported in detail at one of the group sessions on refinery technology during this meeting."

REFINING GROUP SESSIONS

The General Committee on Refiner Technology this year rounded out a highly interesting and instructive program consisting of 19 papers which were presented and discussed at five group sessions. These group sessions were conducted in symposiums covering such topics as motor fuel, cracking, corrosion of equipment, general technology and gum. At no previous meeting of similar nature have technical sessions been so well attended nor as much interest evidenced in the proceedings. At the first session the subject of motor fuels was discussed.

MOTOR FUELS

In their discussion of vapor pressures of gas-free gasolines, Oscar C. Bridgeman, Elizabeth W. Aldrich and Hobart S. White, all of the Bureau of Standards, reported experiments in vapor pressure measurements, accurate to about one mm, having been made over a considerable temperature range on 16 motor fuels and 17 aviation fuels. Using the A. S. T. M. temperature at one per cent evaporated and the slope of the A.S.T.M. curve at this point, a general relation can be used to compute vapor pressure data on gasolines with a precision of 0.2 pound per square inch. Auxiliary data are presented on normal bubble points by a special distillation method and on the variation of vapor pressure with increase in vapor volume. Appendix 1 gives new volatility data at temperatures below zero degrees Centigrade; while Appendix 2 presents a final correlation of the volatility work on 38 fuels in which the A.S.T. M. distillation data permits evaluation of the desired information with a precision of one degree Centrigrade.

The normal bubble points were found to be equal to the 10 per cent A.S.T.M. temperatures, corrected for loss, within the accuracy of determining the latter. A number of special A.S.T.M. distillation experiments were made in which liquid temperatures were recorded, and the initial boiling points were found to be equal to the 10 per cent points and the normal bubble points, with an average of about one degree Centrigrade in each case.

Donald B. Brooks and Clarence S. Bruce of the Bureau of Standards, in their discussion of fuel volatility and engine acceleration, report the results of a series of experiments in the determination of factors affecting acceleration. They state that the magnitude of the relative effectiveness for acceleration varies considerably from one engine to another. It is believed that the results described justify the following empirical rule for finding the relative effectiveness of fuels for acceleration at any given manifold temperature. Multiply the manifold absolute temperature by 1.2—convert this into units of ordinary temperature. From the A. S. T. M. distillation curves select one fuel which approximates U. S. motor gasoline as the reference, and note its per cent evaporated at the temperature found above. Then the arrangement of the other fuels at this per cent evaporated indicates their relative effectiveness for acceleration at the manifold temperature in question, those having higher A.S.T.M. temperatures being poorer, and conversely. Further, a quantitative relation between any pair of fuels may be roughly ascertained by a comparison of their absolute temperatures.

TESTING LABORATORIES

H. L. Horning, Waukesha Motor Company, in his discussion, "Standardization of Anti-Knock Testing," reported in detail the work of the committee to date. It was decided that a universal knock testing engine should be produced on which all of the most promising methods of determining the knock value of fuels could be tried. This required that the engine could be made an ell head or a variable compression valve-in-head type. The committee then determined a program in which eight laboratories were to use the engine developed for this purpose in testing six fuels by four methods. The status of this matter is now at the point where engines have been built and run for several months in the eight laboratories that will cooperate in these tests. The procedure for four tests has been determined and the fuels are at the laboratories. Preliminary runs are now about to be made at the Bureau of Standards and the Waukesha

(Continued on page 108)

California Refiners Processing Too Much Crude

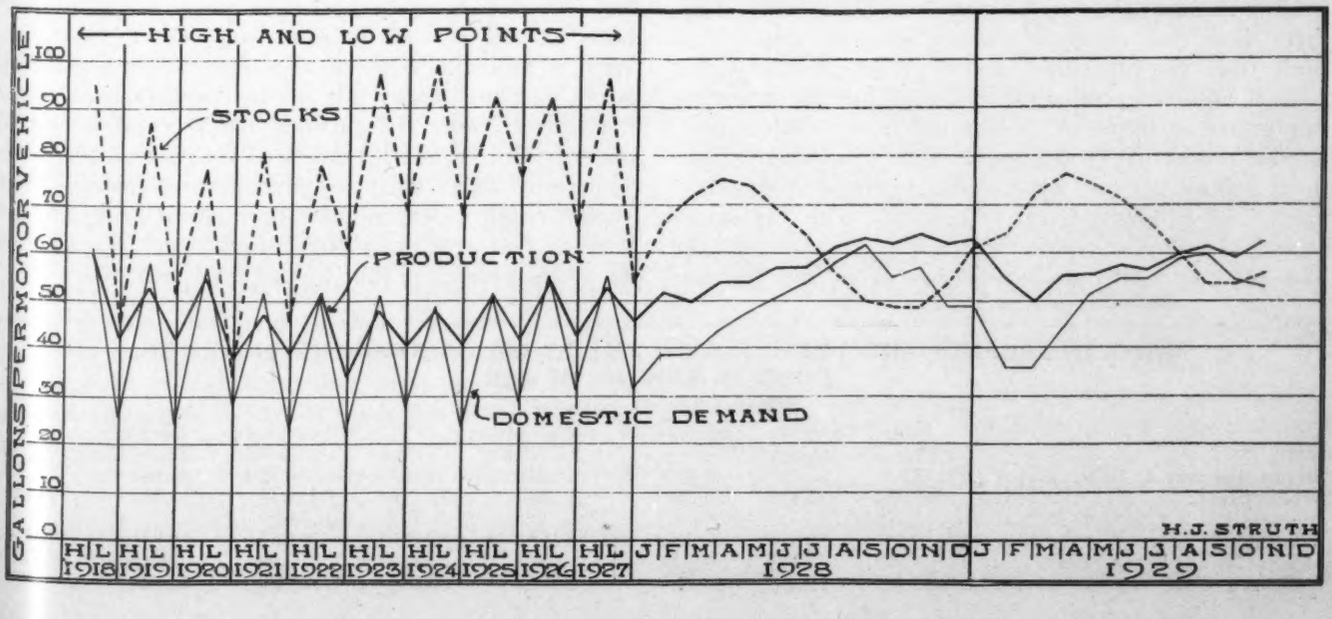
By H. J. STRUTH
Staff Economist

IT has been frequently stated that the refining industry is overproducing gasoline, as a result of running too much crude through stills. The Bureau of Mines report for October, 1929, shows that during the first 10 months of this year 825,984,000 barrels of crude was run through stills in the United States. On the basis of actual gasoline consumption over that period, it is apparent that the industry has consumed approximately 4,443,000 barrels of crude in excess of normal requirements. Table 1 shows that 320,401,000 barrels of gasoline was actually required from refineries, which, on the basis of an average yield of 39 per cent., represents a normal throughput of 821,541,000 barrels of crude. Supporting this conclusion, as shown by Table 2, is the fact that gasoline stocks in the United States have actually increased 1,976,000 barrels, from January 1 to November 1, 1929. This surplus gasoline supply, on a 39 per cent. recovery basis, represents approximately 4,443,000 barrels of crude.

Further analysis of refinery runs by major districts focuses attention upon a most unsatisfactory condition which prevails in California. Detailed analysis of stocks, production and shipments in the major refining areas reveals that California is responsible for the indicated overproduction of gasoline. In fact, practically all other sections of the United States reflect a more satisfactory condition than is perhaps generally realized. The Bureau figures show that refineries of the East Coast, Appalachian, Indiana-Illinois, Oklahoma-Kansas, and Louisiana-Arkansas have experienced substantial declines in gasoline stocks since the first of this year. On the other hand, Texas, Rocky Mountain and California refineries show increases in gasoline stocks, with California in the forefront as the chief overproducer of gasoline. Evidence of this is shown by the fact that California refiners produced during the 10-month period 76,393,000 barrels of gasoline, while actual shipments only aggregated 71,089,000 barrels, an overproduction of 5,304,000 barrels. This figure also checks with the net increase in gasoline stocks of the state since the first of the year. In contrast with this unfavorable situation is the favorable condition that apparently exists among refiners of the East Coast. Here, production during the same period aggregated 47,088,000 barrels while shipments amounted to 53,489,000 barrels. The difference was offset to some extent, however, by imports of foreign gasoline, but stocks showed a decline since the first of the year of 1,025,000 barrels. All other refining areas reveal a rather satisfactory condition, in that production was slightly below shipments, while stocks were slightly below the figures of January 1.

In an effort to determine the extent to which California is overproducing gasoline, the writer found that the gasoline consumption of that state, including shipments to the East Coast, as well as exports, necessitated

Gasoline Production, Domestic Consumption and Stocks Expressed in Gallons Per Motor Vehicle



the manufacture of 57,571,000 barrels of gasoline from crude and approximately 13,518,000 barrels of natural gasoline. Since the average recovery of gasoline from crude in California is approximately 30.8 per cent., it follows that the normal throughput during the first 10 months of the year should not have exceeded 186,000,000 barrels of crude. Actually, California refiners consumed 203,963 barrels of crude, or an indicated excess of 17,963,000 barrels. This condition is decidedly unsatisfactory and demands immediate attention on the part of those responsible for this excess. If California refiners had maintained a reasonable degree of control over their operations, the result would have placed the industry in a highly favorable condition at this time. As it is, the benefits of improved economic conditions in other refining areas have been obscured by the piling up of excessive gasoline supplies in California that are forced into competition with other refining areas.

Table 3 shows the condition of the gasoline situation by major refining areas. Careful study of this data proves that the indicated excessive processing of crude, with a consequent overproduction of gasoline is not general, but is practically confined to California. In view of the remarkable strides that have been made in the curtailment of excessive crude oil production in California, it is logical to assume that equally stringent curtailment efforts must be resorted to there immediately, if the industry expects to benefit from the improved crude situation. The next step in curtailment in California should be directed at refinery crude runs, and the time to begin such constructive effort should not be delayed beyond January 1. Inventory conditions on the Pacific Coast prompt concerted action in this direction that deserves the whole-hearted support of every refiner in California. Just as curtailment of excessive crude production worked directly to the benefit of producers, so curtailment of still runs in California will react to the benefit of refiners there and elsewhere in the United States. Stabilization has become the watchword of the petroleum industry and the movement cannot be satisfactorily completed unless the refined oil situation also reflects economic stability.

Aside from the unsatisfactory conditions prevailing in California, it cannot be said that the gasoline situation is quite as unsatisfactory as many seem to believe. The facts show that economic stability depends almost entirely upon the immediate course of still runs in California. Gasoline production and stocks of the country, interpreted in terms of gallons per motor vehicle registered, reveal that production during October amounted to 62 gallons per car, while stocks aggregated an average of 55 gallons per car. Compared with the same period of last year, stocks represent a gain of six gallons per car, while production was about two gallons less per car than during October of last year. Some idea of the course of gasoline production, demand and stocks per motor vehicle can be gained from the accompanying chart. The chart reproduced on page 160 of this issue also shows the status of refinery crude runs since January, compared with normal requirements. It will be noted that runs during October turned sharply upward; practically all of the gain being credited to California.

If California refiners had maintained still runs within the limits prescribed by the gasoline demand, the industry would now have reached the stage where gasoline stocks would have aggregated only 43 gallons per motor vehicle instead of 55. Such a condition would have been highly favorable to the industry and certainly have offered a much brighter outlook for next year. As it is, still runs continue at a high rate in California, while gasoline stocks pile up to the detriment of all concerned. Since the facts at hand reveal a decided necessity for immediate action on the part of California refiners to adopt adequate curtailment measures, there should result a determined movement to bring refinery runs of that area down to a normal level. To do so is to insure greater profits for all next year.

TABLE 1

Analysis of Gasoline Requirements and Normal Crude Still Runs

First 10 Months of 1929—	Barrels
Domestic Gasoline Consumption	313,800,000
Exports of Gasoline	51,150,000
Total Consumption	364,950,000
Imports	7,000,000
Net American Gasoline	357,950,000
Natural Gasoline Content	37,549,000
Net Gasoline from Crude	320,401,000

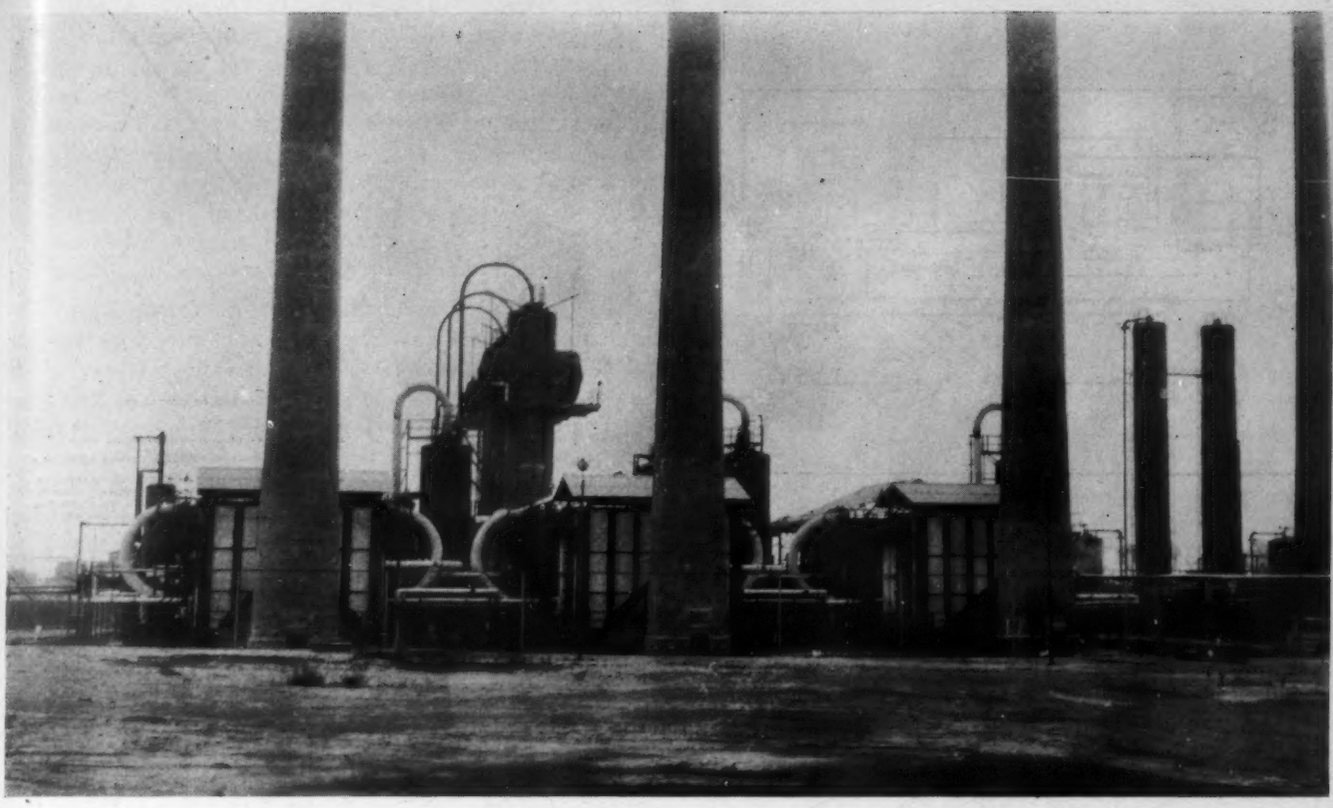
TABLE 2

Gasoline Situation

First 10 Months of 1929—	Barrels
Stocks January 1, 1929	33,066,000
Production	359,758,000
Imports	7,168,000
Total	399,992,000
Consumption	364,950,000
Stocks November 1, 1929	35,042,000
Net Increase in Stocks	1,976,000

GASOLINE SUPPLY AND DEMAND ANALYSIS BY MAJOR REFINING DISTRICTS
FIRST 10 MONTHS OF 1929
(Thoustands of Barrels)

	East Coast	Appala-chian	Indiana-Illinois	Oklahoma-Kansas	Texas	Louisiana-Arkansas	Rocky Mountain	California
Stocks January 1, 1929	5,537	1,229	5,099	3,691	4,863	2,158	1,568	8,921
Production	47,088	13,421	54,058	51,893	77,318	25,634	13,953	76,393
Imports	5,376	....	....	.....	717	1,075	.....	.....
Total	58,001	14,650	59,157	55,584	82,898	28,867	15,521	85,314
Stocks November 1, 1929	4,512	995	4,333	2,782	4,889	1,598	1,717	14,225
Indicated Consumption	53,489	13,655	54,824	52,802	78,018	27,269	13,804	71,089



Three units of Gyro Vapor Phase Process at the Pure Oil Company's Marcus Hook refinery

Principles of Vapor Phase Cracking

By R. C. OSTERSTROM and C. R. WAGNER
The Pure Oil Company, Chicago, Illinois

WHEN liquid phase cracking was first developed, the process was carried out in shell stills under a pressure of five to seven atmospheres. Gasoline and fixed gas formed by cracking distilled over at the temperatures and pressures employed, leaving the gas oil and fuel fractions behind to be subjected to higher temperatures for the entire period of the run. In the beginning of this development, and during the early commercial use of liquid phase cracking, a distillation rate of two per cent of the charge per hour was maintained generally, and distillation was stopped when about 50 per cent of pressure distillate had been obtained. This distillation rate was increased from time to time, after about ten years the first stills of this type were introduced which maintained a rate of six per cent. per hour. Strangely enough, the distillate produced at these higher rates was of higher A.P.I. gravity, and fuel oil and gas were produced in smaller quantities than at the lower distillation rates. It was also possible to take off up to 65 per cent of distillate without danger, though such a practice earlier would have been severely condemned. To a large extent, this development was made possible by the coincidental development of fractionating devices. Careful investigation revealed that time and temperature were the factors affecting these reactions, and that up to a certain point, at least, pressure acted only as a means of keeping the oil in the higher temperature zone, until decomposition to the desired extent took place. It was apparent, furthermore, that it was necessary to remove the gasoline from the reaction zone and cool it to ordinary temperatures as rapidly as possible to avoid its destruction through secondary reactions even to ultimate decomposition.

RITTMAN'S CONCLUSIONS

When a study of vapor phase cracking was undertaken by us it was evident, therefore, that particular attention would have to be given to the relations existing between time of reaction and temperature and the yields of useful products obtainable. This problem[1] was also studied by Rittman[2] and his associates, who came to the following conclusions:

"In procuring the desired products of the cracking reaction, the physical and chemical properties of

[1]An excellent resume of the literature with complete bibliography may be found in an article by Lomax, Dunstan and Thole, J. Inst. Pet. Tech., 3, 36-120, 1916).

[2]Bul. 114, U. S. Bureau of Mines.

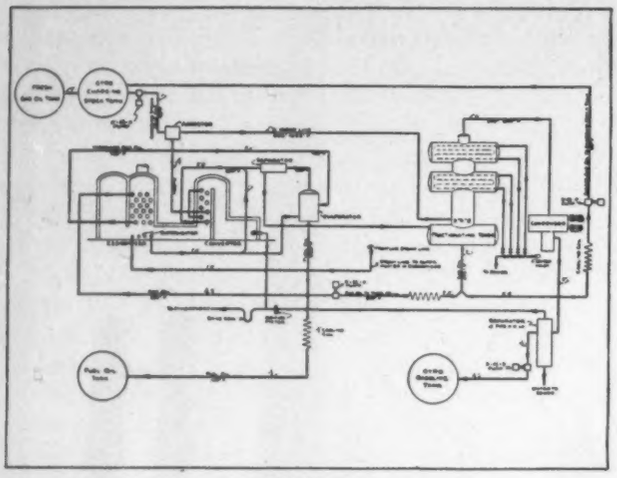


FIGURE 1

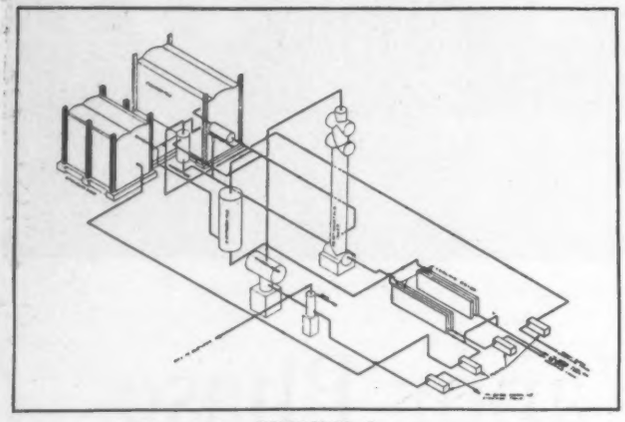


FIGURE 2

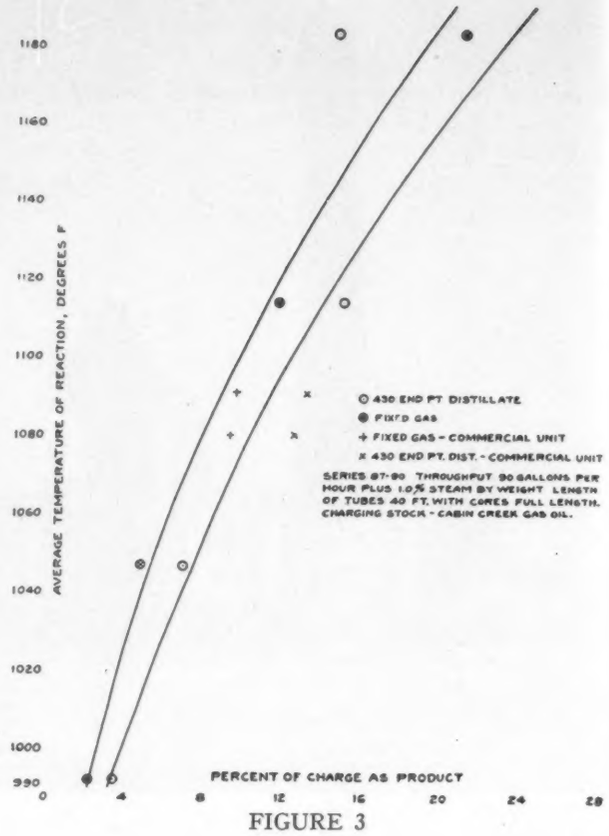


FIGURE 3

an original oil are of secondary importance compared with the influence of temperature, pressure, time, and concentration."

Considerable data is given in Bulletin 114 to show the effect of pressure on the character of the products of the reaction, but the effect of pressure upon the time of the reaction is not clearly brought out. These authors do point out the fact that concentration must vary in a gaseous reaction with the pressure employed.

We realize that measuring the time of such a reaction with a stopwatch was out of the question. In view of the many advantages of low pressure systems, it was decided to maintain pressures as low as possible and still get the pressure drop through the system required to get capacity. This eliminated for the time being the question of pressure effect. Measurement of time was attempted by regulation of the cubical capacity of the cracking apparatus and by accurately controlling the volume of liquid oil cooling medium fed to the vaporizing unit. Temperatures were measured by means of thermocouples, partly indicated and partly recorded.

A flow sheet of the process used is shown in Figure 1, while an isometric view of the apparatus is given in Figure 2.

In Figure 3 are recorded graphically the results of a series of runs to determine the effect of temperature upon the rate of cracking. Data are included

TABLE I

Run No.	89	87	88	90	93
Temperature of cracking, deg. F.	942	992	1047	1114	1186
A. P. I. gravity	52.7	56.5	55.1	52.8	44.4
Distillation Data					
Initial boiling point, degree F.	103	110	104	106	106
10 per cent point	200	184	180	183	188
20 per cent point	242	214	216	216	222
30 per cent point	273	237	240	242	246
40 per cent point	299	258	267	268	282
50 per cent point	321	277	291	294	313
60 per cent point	341	295	312	318	346
70 per cent point	355	316	333	344	374
80 per cent point	370	337	353	368	402
90 per cent point	390	366	375	400	442
End point, degree F.	429	444	412	452	493
Iodine No.	197.0	220.1	231.1	216.8	191.7
Cubic feet dry gas per gallon 430 end point distillate	32.7	53.9	56.2	58.2	105.8

to show a comparison of the experimental results with plant operation where the time element is the same, so far as throughput and length of tube are concerned. The increase in cracking rate on the commercial unit is undoubtedly due to the fact that cracking temperatures were reached much more quickly because of the greater amount of radiant heat available. This had the effect of increasing the time of reaction somewhat. Table 1 gives a comparison of the distillates obtained in this series of runs.

Unfortunately in the early part of this work in this experimental apparatus, it was impossible to secure good fractionation above a certain tower load; and the results are not easily compared, therefore. Two things, however, become evident at once from an inspection of the properties of these distillates. In the first place, the average boiling point of the distillates (if they were all rerun on the same column to a 430 end point) decreases as the temperature of cracking increases. This decrease in average boiling point would be accompanied by an increase in iodine number according to the figures shown. In the second place, the production of fixed gas progressively increases as the temperature increases. This at once suggests, as has been proposed before, that gas is the product of secondary reactions and not of primary reactions. Thus the cracking reaction in No. 89 proceeded so slowly that secondary reactions were held to a minimum, and only heavy gasoline fractions were made. In No. 93, however, the reaction rate was so high that large quantities of fixed gas were produced at the expense of the motor fuel fractions.

Figure 4 shows the results of another series of tests under the same conditions, except that the time element was increased by 150 to 200 per cent. The characteristics of the distillates produced are shown in Table II.

With the exception of runs 104 and 109, these figures also seem to fall in line with the data previously given. In all cases it will be noticed that there is no lack of light motor fuel fractions; further proof of the need for time in the production of gas and light motor fuel fractions.

Figure 5 shows the results of a series of runs made

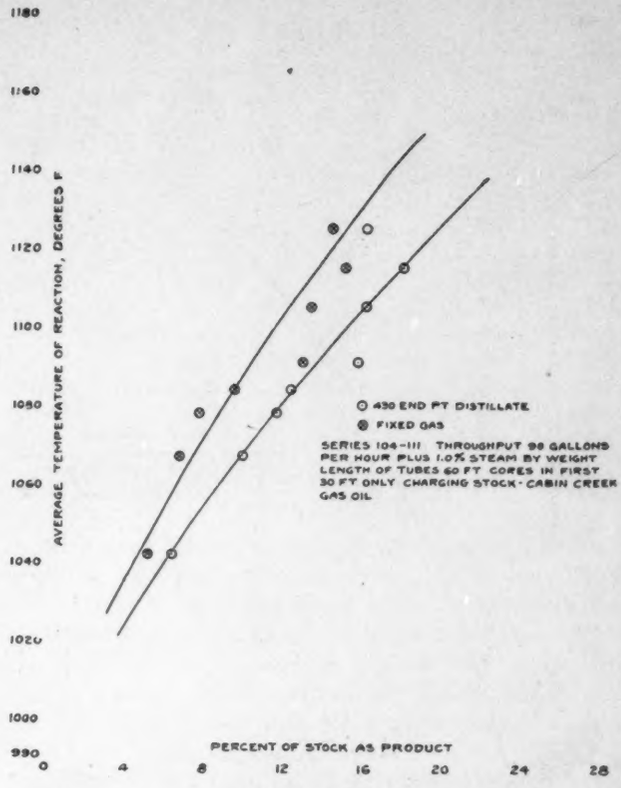


FIGURE 4

with a 20 foot tube. Here it was thought best to show outlet temperature rather than average temperature, because most of the distance was required in getting up to temperature, and the average vapors were subjected to these temperatures for a very short time. Unfortunately some of the data on these runs are not available, but Table III shows what is at hand on the distillates produced.

Though incomplete, the data here again indicate that the formation of gas is a secondary reaction. The most logical explanation of the gas formed in these experiments is local overheating, it would seem. As the temperature rises, the time necessary for starting these secondary reactions decreases. If this theory is correct, then the passage of gasoline boiling point distillate through the converter should lead to the formation of gas and polymerized frac-

TABLE II

Run No.	104	105	109	106	111	107	110	108
Temperature of cracking degree F.	1042	1067	1078	1084	1091	1105	1115	1125
A. P. I. gravity	56.3	55.3	55.7	53.3	50.2	52.6	51.7	51.4
Distillation Data								
Initial boiling point, degree F.	111	109	121	111	126	117	109	117
10 per cent point	180	181	177	181	191	182	188	186
20 per cent point	208	211	203	202	224	216	219	216
30 per cent point	229	235	226	237	250	240	240	241
40 per cent point	246	257	244	259	276	263	271	265
50 per cent point	261	278	267	288	307	288	296	289
60 per cent point	289	298	288	312	338	316	321	312
70 per cent point	307	320	306	336	364	340	345	340
80 per cent point	330	342	327	360	391	366	373	366
90 per cent point	356	367	350	389	416	395	408	396
End point, degree F.	394	399	382	421	452	428	454	432
Iodine No.	215.8	209.6	235.8	223.4	182.7	202.2	212.0	224.7
Cubic feet gas per gallon 430 end point distillate	65.2	55.3	53.0	62.3	66.2	67.0	67.0	72.3

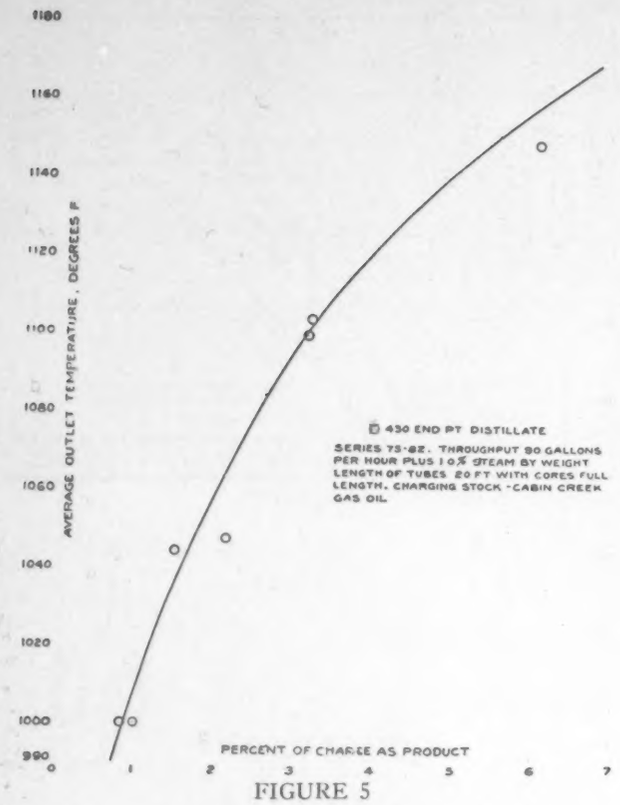

AVERAGE OUTLET TEMPERATURE, DEGREES F
PERCENT OF CHARGE AS PRODUCT
430 END PT DISTILLATE
SERIES 73-82. THROUGHPUT 90 GALLONS PER HOUR PLUS 10% STEAM BY WEIGHT LENGTH OF TUBES 20 FT WITH CORES FULL LENGTH. CHARGING STOCK - CABIN CREEK GAS OIL

FIGURE 5

tions in as great or greater quantities than would be the case if gas oil vapors instead were delivered to the converter. Furthermore, the gas produced in such a test should have the same characteristics as gas produced in the experiments just cited.

To try out this idea, the system was thoroughly cleaned out and 426 end point distillate was used as charging stock. Owing to the small tower capacity, it was not possible to get the charging rate up to 90 gallons per hour. The tower bottoms, which accumulated and were not returned to the system, contained considerable motor fuel fractions for the same reason. In comparing these results with ordinary operation, it should be remembered that they represent a once-through basis, whereas regular operation calls for a recirculation ratio of between 2.75:1 and 4.00:1. Table IV gives a comparison with operation on Cabin Creek gas oil at approximately the same temperature and with exactly the same converter set-up. The time element was longer for the run on distillate, because the throughput was less, although this was partially offset by a higher steam ratio.

Of the polymerized fractions accumulated in the tower bottom, about 10 per cent were heavy fuel exactly similar to the fuel produced in the regular way when cracking gas oil. The remainder resembled the recycle fractions produced as a reflux in the tower during normal operation.

It seems fairly certain from these data that gas is a product of secondary reactions, as is also fuel oil. If this were not the case, and gas were the product of primary reactions, then we would expect wide differences in the quality of the gas made from a variety of charging stocks. Complete data on this point have not yet been collected, but the following analyses from widely different charging stocks when taken with the above indicate the similarity on origin of the gases produced.

Partial analyses have been made also on gases from Spindletop, Sweet Lake, Smackover and Mexican crudes. Except for variations in CO_2+H_2S, they were very nearly identical sofar as figures were obtained.

These data all indicate that it is highly improbable that we have in the final products under these operating conditions any large quantities of material which represent entirely the products of primary reactions in the disintegration of the gas oil molecule. It was thought interesting, therefore, to make some rough calculations as to the time occupied by any given particle of gas oil in passing through the converter. By means of exploring thermocouples and sample cock connections, temperatures and analyses of vapors were obtained at the end of each pass in the converter. Using Boyle's law, and assuming molecular weights for the various fractions, it was possible to calculate velocities and from these estimate roughly the time of exposure to heat. It is appreciated that such methods can lead at best to approximations, but they should be not more than 25 to 50 per cent in error.

By these methods, we found that it required from 0.8 to 1.5 seconds for vapors to pass through the con-

TABLE III

Run No.	76	82	81	77	75	79	78
Temperature of cracking degree F.	1000	1000	1044	1047	1099	1103	1148
A. P. I. gravity	....	46.0	....	....	....	....	54.1
Distillate Data							
Initial boiling point, degree F.	....	122	....	....	....	....	110
10 per cent point	....	258	....	....	....	....	182
20 per cent point	....	330	....	....	....	....	213
30 per cent point	....	365	....	....	....	....	241
40 per cent point	....	387	....	....	....	....	267
50 per cent point	....	398	....	....	....	....	292
60 per cent point	....	409	....	....	....	....	315
70 per cent point	....	418	....	....	....	....	341
80 per cent point	....	429	....	....	....	....	365
90 per cent point	....	447	....	....	....	....	397
End Point, degree F.	....	489	....	....	....	....	452
Iodine No.	....	129.5	....	....	....	....	221.4
Cubic feet dry gas per gallon, 430 end point distillate	48.5	16.4	38.9	40.4	45.8	53.0	51.5

TABLE IV

Run No.	51	91
Charging stock	Cabin Creek Gas Oil	426 End Point Dist.
Temperature of cracking degree F.	1068	1070
Gallons charged per hr.	93.5	47.2
Per cent steam by wt.	0.6	1.8
Per cent 430 end point dist. made	63.8	63.7
Per cent dry gas made	29.7	20.8
Per cent fuel (or polymers) made	6.0	15.1
Recirculation ratio	3.82	1.00
Dry gas made per hour, cubic feet	579	781
Specific gravity of dry gas	1.050	1.041
$CO_2 + H_2S$	0.1	0.2
O_2	0.0	1.5
N_2	0.0	6.6
CO	0.1	0.3
H_2	5.8	6.3
Olefins	52.2	50.4
C_nH_{2n+2}	41.8	34.7
Value of n	1.3	1.32
A. P. I. gravity of dist.	54.9	52.0
Iodine No.	209.8	213
Distillation Data		
Initial point, degree F.	100	90
10 per cent point	152	138
20 per cent point	191	165
30 per cent point	224	188
40 per cent point	258	212
50 per cent point	294	237
60 per cent point	328	266
70 per cent point	362	302
80 per cent point	386	343
90 per cent point	410	390
End point, degree F.	435	436
Loss, per cent	2.9	3.7

verter, depending upon the length of tube and the temperature employed. Of this time 0.10 to 0.20 seconds was required in getting the vapors up to the cracking temperature, and during this preheating period practically no cracking occurred as measured by gas and gasoline production. It is evident, then, that any attempt to determine the course of the cracking reaction at these temperatures by experimental means must provide for the separation of samples after a contact time of much less than a second. The tendency of gases and vapors to cling to surfaces makes the problem much more complicated, because any material thus held will be heated to higher temperatures and for a longer time than the average throughput. This results in very erratic results, and in most cases leads to misleading conclusions. It is definitely known that such parasitic cracking occurs up to velocities of 3,000 feet per minute, although it decreases rapidly after a velocity of 2,000 feet per minute is reached.

At this time, work is in progress on the development of a laboratory scale vapor phase cracking unit which will give results that can be interpreted in terms of plant operation. When this has been accomplished, we hope to be able to carry our researches to the point where we will have some data

TABLE V

Charging Stock	Cabin Gas Oil	Cree Gas Oil	Mid-Continent Gas Oil
A. P. I. gravity of charge	39.8	39.5	32.4
Temperature of cracking degree F.	1050	1150	1080
Per cent steam used	3.5	0.0	1.5
Specific gravity of gas	0.985[3]	1.06	1.005
$CO_2 + H_2S$	0.3	2.7	0.4
O_2	0.2	0.0	0.3
N_2	0.3	0.0	1.0
CO	0.2	0.3	0.3
H_2	6.7	5.8	6.5
Olefins	55.75	51.3	51.5
C_nH_{2n+2}	36.75	39.9	40.0
Value of n	1.40	1.2	1.3

[3]Of doubtful value, as determination was made by effusion method.

on the character of the primary cracking reactions occurring at these temperatures. Up to date, however, it has been possible to study only conditions approximating those found in plant operation. While it is not possible to present all of the supporting data in a paper of this character, it has been fairly well proved that the following generalizations hold true:

1. Up to two atmospheres pressure, the only effect of pressure upon the cracking reaction in the vapor phase is to increase the time factor.

2. For a given time a reaction, increasing the temperature will increase the ratio of fixed gas to motor fuel produced.

3. For a given temperature of reaction, increasing the time will increase the ratio of fixed gas to motor fuel produced.

4. Between 1,050 degrees F and 1,150 degrees F., changing time or temperature has relatively little effect upon the quality of the distillate produced, unless the time is so short as to give a recirculation ratio in excess of six to one.

5. Low vapor velocities in zones of high heat transfer result in high gas to motor fuel ratios.

6. The vapor phase cracking reaction is strongly endothermic and, therefore, requires the addition of large amounts of heat to maintain the cracking temperature contact.

7. Although variation in the quality of the charging stock causes some variation in the quality of the motor fuel produced, this tendency is much less marked than at the lower temperatures employed in liquid phase cracking. On the other hand, it is conceivable that the quantities of a given quality of product produced might vary a great deal more with variations in physical and chemical properties of charging stocks than is the case in liquid phase cracking—assuming that optimum operating conditions in the two methods of cracking are obtained before comparisons are drawn. It is also thought possible that, even though the quantities and the qualities may not be materially affected, yet it is entirely conceivable that the extent of treating necessary to produce a finished, stable product may be influenced by the chemical properties of the original charging stock. Research work along this line is now in progress, and will probably be made the subject matter of a subsequent paper.

Some Developments in Commercial Cracking

By A. L. STROUT
Standard Oil Company of California, San Francisco, California

Paper Delivered at Tenth Annual Meeting, American Petroleum Institute, Chicago, Ill., December 4, 1929

As a result of intensive study and experimental work during the past few years, we have succeeded in determining principles which influence the formation of coke in the cracking process and the character of the cracked fuel oil as regards sediment. Having determined how to apply these principles through the design of equipment and method of operation, the benefits resulting therefrom have been realized to a gratifying degree with our commercial units.

Likewise, the problem of stripping cracked gas of its gasoline content, eliminating hydrogen sulphide and stabilizing pressure naphtha, offered many vexing problems. A unique method for accomplishing this was developed simultaneously with the solution of many of our other cracking problems, and is now standard equipment on our pressure cracking units. This paper is presented in two parts, and deals briefly with these important features of cracking.

PART 1. CAUSES AND CONTROL OF COKE FORMATION

There are two distinct methods of operating cracking plants: cracking to coke without leaving a liquid residuum, and cracking to a liquid residuum. In the latter process, it is desirable to obtain a maximum yield of gasoline, with a minimum of coke and a high quality of residual fuel.

This paper discusses the latter process, with particular stress on the causes and methods for controlling coke and sediment formation. The discussion is confined to principles. Specific data are generally omitted because they are of little significance, due to the great number of variables which will affect results. It is believed, however, that the principles presented are of general application.

Before proceeding further, it will be desirable to define some of the terms used. "Gasoline" refers to the naphtha withdrawn from the system. "Tar" defines the liquid residuum of high carbon-hydrogen ratio removed from the process. The term "coke" is used in the popular sense to designate the carbonaceous material produced in the process. A new term is introduced, viz., "ultimate tar," to describe a heavy tar which cannot be cracked further without producing coke or sediment.

When an oil is subject to cracking conditions, the reaction is progressive. The products formed are gas, gasoline, intermediate oil, tar, coke, and sediment. There is evidence that all of these products are not formed simultaneously during the breaking up of an original compound. Coke formation especially appears to proceed through the stages intermediate oil, tar, ultimate tar, and finally coke; that is, coke will not be formed unless cracking is carried beyond a certain definite point, and it results not directly from the decomposition of original compounds but from the progressive cracking of the tars formed during the decomposition of intermediate oil beyond the "ultimate" stage.

Figure 1 illustrates these relations. It will be evident that only a limited amount of gasoline can be formed in a single cracking step if coke formation is to be avoided. A large portion of the original charging stock will remain in the form of intermediate oils, which cannot be cracked further without at the same time degenerating part of the tar formed into coke. The reaction could be carried, of course, to coke and gas as ultimate products. Sediment also appears in the residuum at some stage of the process.

CYCLING CRACKING

The amount of cracking allowable per cycle is not readily established, inasmuch as the nature of the stock entering a cycle will be an important factor. Less cracking per cycle can be permitted on stocks of high carbon-hydrogen ratio, such as topped crudes, than on light distillates if coke is to be avoided. It will also be apparent that, by reducing the amount of cracking per pass, the danger of coke formation can be quite definitely avoided. This may prove an aid in overcoming other unfavorable conditions that may exist in the cycle, such as excessive metal temperatures in the heating element.

The continuous removal of ultimate tar, gas, and gasoline, as produced, would be an ideal procedure, and would entirely eliminate the production of coke and result in a high yield of light products; but this procedure does not appear practical, and other means must be sought.

An approach to the continuous removal of the prdoucts of cracking is found in the practice of cycling with the removal of tar, gas, and gasoline after each cycle.

It is evident that this practice cannot result in the maximum possible yields of gasoline without the forma-

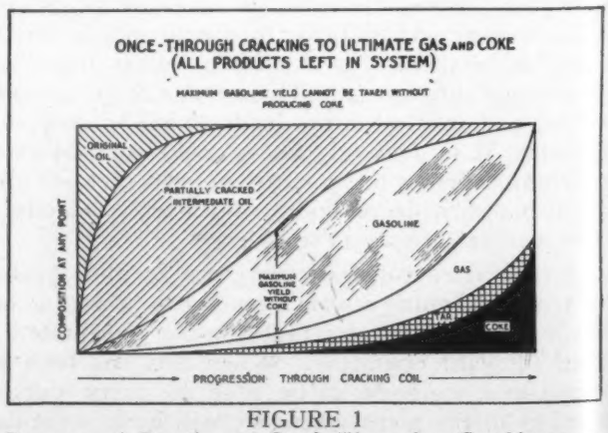


FIGURE 1
Progress of Reaction of Stock Through a Cracking Cone

tion of coke. This is because a small part of the gasoline produced early in the cycle will crack to produce some gas and some intermediate oils, and the final result will be a loss of gasoline by recracking. Further, the tar that is removed will consist of a mixture of fractions that could yield gasoline, and ultimate tar which, if cracked further, will produce coke. Cyclic cracking can, therefore, only approximate the ideal process in which the ultimate tar is removed continuously as formed.

CONTROL OF COKE FORMATION

There are two elements common to most cracking processes: the coil heating element in which a certain amount of cracking takes place, and a second element in which the cyclic cracking is continued. This secondary element may serve as a separator for liquids and vapors and act incidentally as a digester, or it may be installed primarily as a digester to promote cracking.

Coil: In the progress of the stock through the coil, the vapor and liquid are in a state of intimate mixture; and, as a result, all increments of the stock remain in the coil approximately the same length of time and are subjected to the same temperature conditions.

If a tarfree stock enters the coil and complete agitation exists, such tar as is formed will be subjected to cracking conditions the same time after its formation as the remaining fractions within this element. The average time, then, to which the total tar leaving the coil is subjected will be considerably less than that of the other fractions, including the vapors (when taken as a group). From this standpoint, the coils appear favorable for carrying out cracking reactions.

The most basic control that we have over coke formation within the coils is found in limiting the amount of cracking per pass. This limitation has already been indicated in Figure 1. The design of the furnace, however, may have a very marked influence on coke formation through its control of metal temperatures. Ample heating surfaces set in a furnace, so designed as to distribute the heat uniformly, will lower the maximum rate of heat input and result in lowering the maximum metal temperature. This condition will reduce the so-called "skin cracking," which may be a serious factor in cracking the tar content of the stock beyond the ultimate stage. The velocity of the stock through the coil will also have a considerable effect on the results by influencing the degree of agitation and, therefore, the intimacy of mixture of liquid and vapor. High velocities through the coil are evidently desirable.

Digester: The stock entering the digester carries the tar produced in the coil, and to this is added such tar as is produced by the digestion step of the cycle. If a constant temperature throughout the liquid in the digester is assumed, the degree of cracking to which the tar is subjected will depend upon the time it is held within this element. This time is greatly influenced by the volume of liquid and the concentration of the tar.

Since separation of vapor and liquid takes place in the digester, the relative periods of time of the liquid and vapor within this element will be governed by their relative volumes, densities, and rates of withdrawal. Figure 2 indicates how the liquid volume influences the relative time of liquid and vapor in the digester. This curve is based on the assumed conditions of: 275 pounds pressure, 830 degrees F., 12 per cent. gasoline and 1.2 per cent. gas produced per cycle, and a total yield of 60 per cent. gasoline based on fresh feed.

With a concentration of 50 per cent. of tar maintained in the liquid, this curve shows that the relative time of the liquid to vapor in the digester varies from 65 to 7 as the liquid content varies from 50 per cent. to 10 per cent. The concentration of tar in the liquid exerts a similar influence as illustrated in Figure 3. The curve

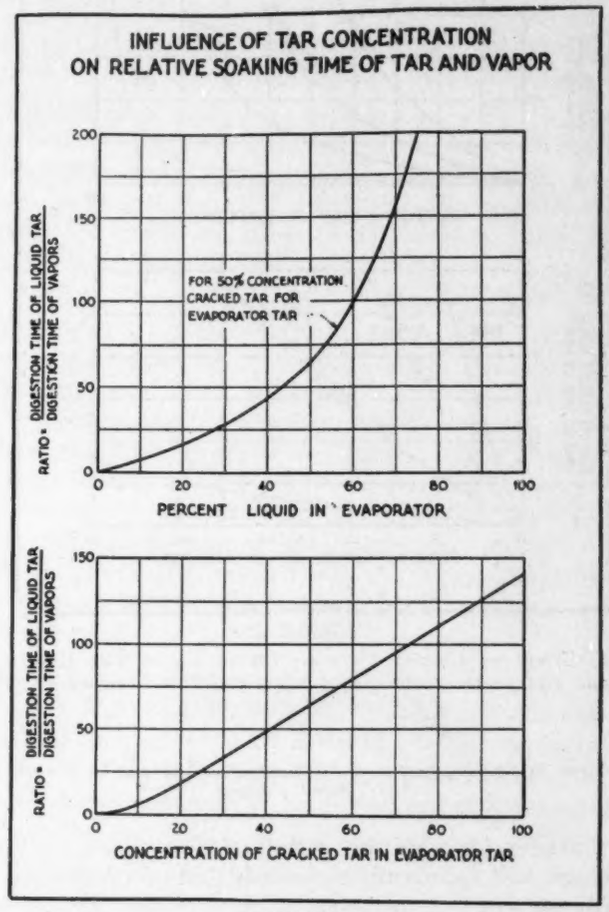


FIGURE 2
Top. Influence of Per Cent of Liquid on Relative Time of Liquid and Vapor in Evaporator

FIGURE 3
Bottom. Influence of Tar Concentration on Relative Time of Liquid and Vapor in Evaporator

is based on the assumption that the digester is held half full of liquid; and in this case, the relative time of the liquid to vapor varies from 65 to three as the concentration of tar varies from 50 per cent. to 10 per cent. This marked influence of tar concentration on the relative times of the liquid and vapor in the digester is due to the fact that the quantity of stock withdrawn as liquid increases, while the quantity of vapor decreases proportionally with the decrease in tar concentration

Figure 4 represents a group of curves showing the influence of both the liquid level and the tar concentration on the relative time of liquid to vapor in the digester. Figure 4-A shows the same group of curves on an enlarged scale to facilitate reading the smaller values. The time the tar content of the stream entering the digester will be held under cracking conditions is in accordance with these curves. The tar formed progressively within the digester will, of course, be subjected

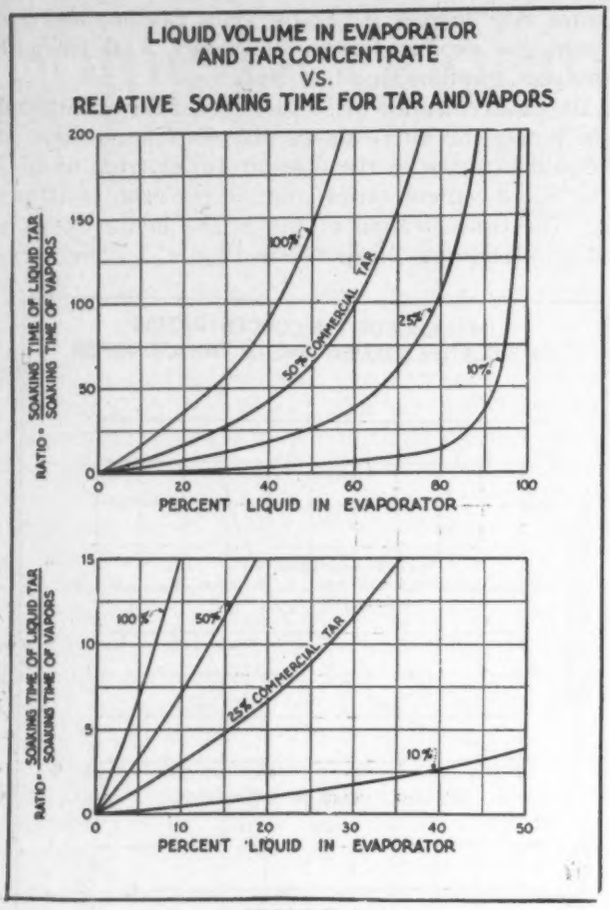


FIGURE 4

Top. Group of Curves Showing Influences of Per Cent of Liquid and Concentration of Tar on Relative Time of Liquid and Vapor in Evaporator

FIGURE 4-A

Bottom. Same as Figure 4 with Enlarged Scale to Magnify the Lower Values

to cracking for a shorter period of time which, on the average, will approximate one-half that of the tar originally present.

It is evident that relative time conditions existing within the coil cannot be readily approached in the digester. A reduction in the size of the digester will exert a beneficial influence by reducing the actual time—and degree to which the tar is cracked—by throwing more of the burden upon the coil. High pressures on the digester will tend to correct the unfavorable conditions by increasing the density of vapors and making it possible to maintain lower concentrations of tar by the liquefication of lower boiling fractions.

Two factors that enter and modify the apparent results illustrated in Figures 2 to 4-A must be taken into consideration: First, the liquid in the digester is actually lower in temperature than the vapor, and the relative degree to which the tar is cracked will, therefore, be correspondingly less. Second, the liquid is in a state of agitation, with the result that some of the stock is discharged soon after its entrance, and conversely some of the stock remains in the digester indefinitely.

The curve is plotted to show the fractional part of oil remaining in a reservoir in which complete agitation is maintained against time in units of average time. This shows that 60 per cent. of the lquid is withdrawn before is has been retained one-half the average time; 36 per cent. remains longer than the average time, and 13½ per cent. remains more than twice the average time. It is evident from this that orderly flow, such as may be obtained in horizontal elements, is advantageous to the prevention of coke and sediment formation, because there is less liability of cracking any part of the tar beyond the ultimate stage.

COMMERCIAL PLANT

A plant which embodies the principles discussed is illustrated in Figure 6. This plant includes a furnace (A) of ample heating surface, in which the radiant heat is well distributed over a large number of tubes and in which high velocities are maintained. The evaporator (B) is of small cross-section, with provision for maintaining the liquid at a low level. This liquid has a commercial tar content of 35 per cent. to 40 per cent., and is withdrawn to a flash still (D) at low pressure where it is distilled by its residual heat. The commercial tar, of about 200 seconds Saybolt at 130 degrees F. is withdrawn from this still, and the vapors are condensed in heat exchanger (E). The condensate from this exchanger passes to mixing chamber (F), to which the fresh feed is admitted. The mixed stocks from chamber

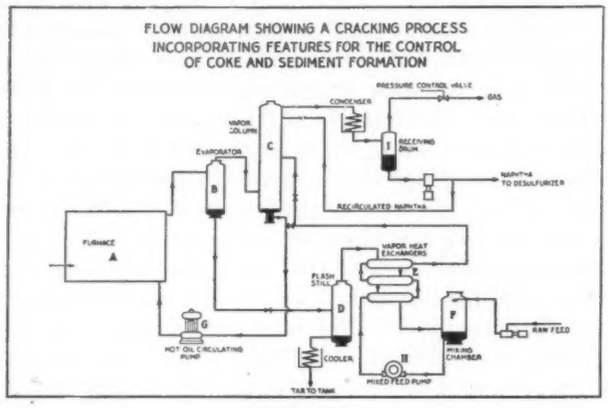


FIGURE 6

Flow Diagram of a Cracking Process Incorporating Features for the Control of Coke and Sediment Formations

(E) are pumped through the exchanger to this system. The vapors from the evaporator pass to a fractionating tower (C), from which naphtha is drawn overhead and cycle stock from the bottom. The cycle stock and fresh feed are pumped to the furnace (A).

A plant of this design will operate successfully on heavy gas oil or topped crude, with practically no formation of coke, and will produce a tar with a sediment approximately 0.3 per cent. to 0.5 per cent. The yield from a plant of this kind will be contingent upon the degree to which the tar is reduced by distillation. The quality of tar withdrawn will be dictated, as a rule by the viscosity required for blending and marketing purposes.

PART 2. DESULFURIZER

In most cracking plants, the naphtha is condensed in the presence of the gases produced in the process. Naphtha and gas are, therefore, in equilibrium. The naphtha is saturated with fixed gases, including hydrogen sulfide, and the gas with gasoline fractions, the saturation depending on the pressure and temperature under which the two products are separated.

It was found that a substantial amount of the fixed

(*Continued on page* 104)

A New Type of Cracking Unit

By LUIS DE FLOREZ
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Paper Delivered at Tenth Annual Meeting American Petroleum Institute, Chicago, Ill., December 4, 1929

THE customary classification of cracking in terms of liquid phase and vapor phase has persisted with more regard for tradition than for fact. In actual practice, a cracking operation producing a gasoline bearing a resemblance to straight run products and accompanied by a realtively low production of process gas, is referred to as a liquid phase process without much regard to the relation of temperature and pressure. A vapor phase process, on the other hand, is customarily regarded as one producing highly unsaturated distillates and a relatively large proportion of gas. Common usage designates cracking operations more in accordance with the nature of the ultimate results than with the characteristics of processing, and thus tends to maintain the existence of a confusing and arbitrary line in the wide borderland which links so-called liquid phase and vapor phase cracking.

A survey of existing practice reveals the interesting fact that products attributed to liquid phase and to vapor phase cracking can be produced within a temperature range of the order of 200°F. and a pressure range of about 300 pounds per square inch. Inasmuch as the characteristics exhibited by the products of a cracking operation are fundamentally dependent upon the temperature and the density maintained during the reaction time, limitation of the use of equipment to one class of operation does not seem justified. This consideration suggests the possibility of developing a cracking unit in which the factors of temperature, time, and pressure can be varied sufficiently to extend its operation to the manufacture of products of either the liquid phase or vapor phase type.

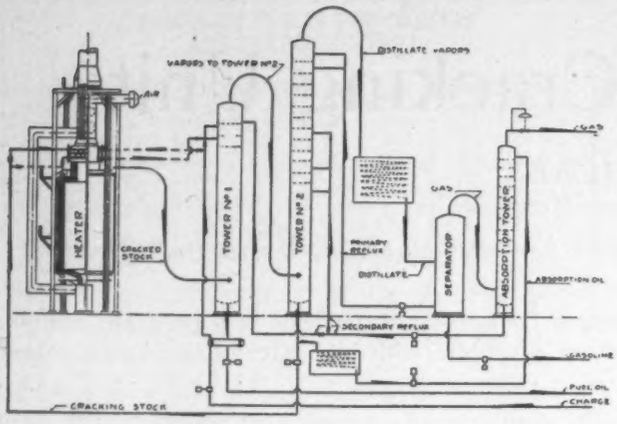
The desirability of such a development is evident. Cracking in the so-called liquid phase, at comparatively low temperatures, has been perfected as the result of a vast expenditure of energy and money, and has become an accepted and necessary means of manufacturing gasoline. So-called vapor phase cracking, on the other hand, at higher temperatures and generally lower pressures, has been considered, heretofore, less suited to the economic needs of the industry, in view of the relatively large productions of non-condensible products which attend such processing. Under ordinary circumstances, it cannot compete in efficiency as a gasoline process, but has received commercial consideration chiefly for the production of its anti-knock values to meet the growing demand for them in modern gasolines. It is recognized that vapor phase cracking has merit, but the industry has been reluctant to commit itself to large expenditures for highly specialized equipment, when the ability of such equipment to compete with standard processing requires the consideration of variable conditions such as: the market for the gas produced, the demand for anti-knock gasoline at a premium, and the absence of crudes with high natural anti-knock values.

The advent of equipment capable of a wide range of results would permit commercial experiments with other operating methods without the financial hazard, thus removing one of the chief obstacles to progress in extending the usefulness of cracking to fields which are not limited solely to the manufacture of anti-knock products.

The problems involved in the design of a cracking unit capable of a wide range of operation are not merely of a structural nature; provision must be made to permit a more or less independent control of the operating factors, such as temperature, pressure and time, in order to bring about the required conditions to produce the type of results desired. These problems present many difficulties, none of which, however, precludes a practical solution if attacked with the clear understanding that cracking at various parts of the scale differs more in detail than in theory of processing.

A solution to these problems has been found in the evolution of a design combining certain structural features and an operating cycle which can be balanced with widely differing rates of cracking per pass. The discussion of this design and its reduction to practice constitutes the subject matter of this paper.

A cracking unit, embodying most of the characteristics sought, was erected at Bayonne, New Jersey, in 1927, and has now been in operation for a little less than two years. The unit has a charging capacity of about 1000 barrels per day of heavy crude, and comprises a heater of approximately 1500 square feet of effective surface, an expansion chamber and fractionating tower 43 by four feet and about 2000 square feet of condensing surface. It has been operated principally on Venezuela crude as charging stock, with a few periods of gas oil operation. Up to the present, it has functioned at the higher temperature ranges, which usually offer the greatest difficulty to continuous operation with heavy charging stock and the most promise for the production of anti-knock distillates. The effect of varying temperatures and pressures has been studied, and it is proposed to continue the study of results, not only under extreme operating conditions but in the intermediate ranges as well. Obtaining reliable data involves long periods of operation under given conditions, which necessarily lengthens the task of research in the field of processing. The adaptibility and efficiency of the equipment, however, has proved successful beyond expectation, and has led to the construction of other similar units whose operation will shortly afford



TYPICAL FLOW DIAGRAM
DEFLOREZ CRACKING UNIT

FIGURE 1

additional sources for commercial data to supplement the existing work.

The operating cycle of the unit is broadly illustrated in the accompanying Figure 2, where A represents the heater, B a combined expansion chamber and fractionator, C an accumulator tank, and D a circulating pump for cycle stock. The charge enters the expansion chamber at E, where it comes in contact with the products discharged from the heater A, which enter the expansion chamber at F. The charge is heated by the products entering at F, and subjected to a cracking distillation which causes the light vapors and recycle stock to ascend into the fractionator. The cycle stock is drawn off at an intermediate point G above the charge inlet, passing into tank C from which it is picked up by the circulating pump D, delivered under pressure to the heater A and, after heating, is discharged into the chamber B, completing the cycle. Naphtha and non-condensible gases are drawn off at the top of the fractionator at H, while the residuum or bottoms are drawn off at the base of the chamber at J.

It may be considered that the unit effects cracking in two ways: primary cracking in the heater coil, and a secondary cracking in the base of the chamber B. The primary cracking is regulated by raising or lowering the outlet temperature of the heater, or by increasing or decreasing the circulation of the cycle stock. The secondary cracking, on the other hand, is regulated by varying the quantity of products retained in the base of the chamber and variations of pressure.

The over-all cracking effect may be modified by the relative extent of cracking in the coil or in the chamber. One is, of course, not entirely independent of the other, but their proper combination permits sufficient variation to obtain the desired flexibility in the formation of various kinds of products. When operating at high temperature and low pressure, virtually all the cracking takes place in the coil and, as might be expected, the resulting products are of the type attributed to vapor phase operation. As the pressure on the system is increased, more cracking can be accomplished in the chamber without coking, the effect of which becomes noticeable in the breaking of the viscosity of the residuum. Concurrently, the character of the distillate changes toward the type usually attributed to liquid phase cracking, the change becoming well defined when pressures of 50 or 60 pounds are reached, the temperature conditions remaining constant. By gradually lowering the heater temperature and raising the pressure, the character of the operation can gradually be changed to obtain results attributed to a liquid phase process.

It is evident from the arrangement that a separation takes place in the base of the chamber B carrying the cycle stock, gasoline and non-condensible gas overhead, leaving the carbon-bearing residual products in the base of the chamber from which they may be drawn off at will. The cycle stock, which is composed of distilled charge and products requiring further cracking, is subjected to fractionation through bubble trays to eliminate any material which might deposit upon vaporization. This feature is requisite to high temperature operations and extremely desirable for low temperature work, as it permits the heater to function at all required temperatures almost indefinitely without the necessity of cleaning. The arangement also permits subjecting the heavier portions of any type of charging stock to whatever extent of cracking may be desired, without recourse to the high pressures normally required when such products are cracked in a pipe coil.

The cycle stock is not only cracked by its passage through the heater, but also serves as a carrier of heat to effect the distillation and cracking in chamber B. The heat requirements at this point obviously vary with the grade of charging stock, and the extent of the distillation and cracking to be performed. The heat requirements is balanced roughly by the temperature of the heater discharge and the rate of circulation established.

The extent to which these factors can be varied is somewhat limited by the extent to which it is desired to crack in the coil, and for practical operation it is found desirable to vary the temperature of the charge by preheat and to employ reflux to obtain an accurate balance. Experience has shown that this balance is not difficult to obtain, and that the permissible variation is quite sufficient to take care of any class of charging stocks, ranging from gas oil to topped crudes, and for operations at high or low temperatures.

In cracking at very low pressures, it is interesting to note that the heat requirement, per pound of charge to the heater, is nearly double that required for usual pressure operations. Consequently the amount of heat delivered to the chamber B is considerably greater per unit of ceirculation. It is found to be in excess of that required for operation on gas oil, which means that cooling must be effected, resulting in a loss of heat. If topped crude is charged to the system, however, this heat is employed usefully in distillation and secondary cracking, making the process thermally more efficient, reducing the heat requirements to about the same figure as is normally found in ordinary pressure still work.

Numerous heat balances have been made with different operating conditions, the result of which points clearly to the fact that the use of gas oil in high temperature, low pressure treatment is an inherent disadvantage thermally. Many schemes for heat exchange are possible, of course, but none can compare in simplicity to the utilization of excess heat by direct contact with heavy products to perform useful work. This fact, taken in conjunction with the relative lower mar-

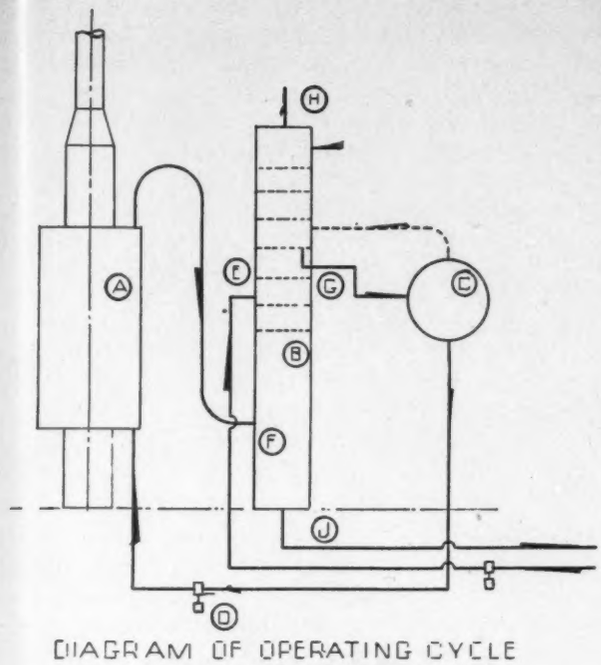


DIAGRAM OF OPERATING CYCLE
DEFLOREZ CRACKING UNIT

FIGURE 2

ket price of heavy charging stock, clearly points to their desirability for treatment in this manner.

The Bayonne unit, which has been used to determine the characteristics of operation of the cycle, was purposely made extremely simple, and when first constructed was not provided with heat exchangers or adequate gas recovery equipment. These features have been added to the design of units now under construction and incorporated in Figure 2, which illustrates diagrammatically the physical arrangement of the equipment. This arrangement is virtually the same as the Bayonne unit with the exception of the chamber and fractionator, which have been separated into two towers for structural reasons, and the features mentioned added.

As shown in Figure 2, the unit comprises a vertical tube heating element, a primary tower providing an expansion chamber and recycle stock fractionating column, a secondary tower providing a cycle stock accumulator and a gasoline fractionating column, a condenser, a gas separator, and an absorption tower for the recovery of gasoline from the gas, together with such supplementary equipment, in the form of heat exchangers and reflux condensers, as may be necessary for efficient operation.

The charging stock, after passing optionally through heat exchangers, is admitted to the primary tower, where it meets the products discharged from the heater. The resulting cracking distillation throws over into the secondary tower the recycle stock together with the gasoline vapors and process gas, leaving the heavy bottoms from the charging stock in the base of the primary tower. From the reservoir in the base of the secondary tower, the recycle stock then passes to a circulating pump and is delivered, at high pressure, from the circulating line to the heating element.

Control in both primary and secondary towers is effected by reflux, utilizing cooled recycle stock for the primary tower and cracked distillate from the gasoline condenser for the secondary tower. The process gas released from the separator is passed through the absorption tower, where the gasoline values are scrubbed out with a portion of the cooled recycle stock. The enriched absorption oil is then utilized as reflux for either the primary or secondary tower, as may be desired. It is to be noted that, if necessary, additional preheat may be given to the charging stock by utilizing a portion of the heater surface before admission to the primary tower.

The practical operation of the unit is largely dependent on the control and the handling of the cycle stock to the heater and the separation of the vapors and liquids in the base of the mixing chamber. The quality of the cycle stock is maintained within definite limits by fractionation through bubble trays against a positive gas oil reflux and continuously observed in a sight glass placed on the control board. It has been found that its color can be relied upon to indicate its carbon forming properties which, coupled with its gravity, constitute a simple method of determining its character. It is drawn from the fractionator in a liquid state at a temperature of between 500° and 600°F., subjected to whatever pressure may be desired to force it through the heater, and then accurately measured through an orifice meter which permits control of its flow. By utilizing comparatively high pressure drops, of the order of 300 pounds per square inch, it is possible to pass it through the heater at very high velocity, which not only permits efficient heat transfer, but avoids any possibility of local heat or parasitic cracking on the walls of the tubes leading to carbon deposit, particularly at high temperatures. The combination of eliminating material which might deposit upon vaporization, and the employment of high velocity, permit the heater to operate for indefinite periods without cleaning.

The incoming vapors from the coil, containing in some cases entrained droplets of tar, are brought into intimate contact with the liquid in the base of the tower, where heat interchange and tar separation without entrainment is obtained by centrifugal action. The centrifugal effect is obtained by admitting the heater discharge through a nozzle tangent to the walls of the chamber, setting up a rotation of both liquid and vapor which not only facilitites separation but actually creates more disengaging surface by giving the liquid a concave form. An efficient separation at this point is extremely important, as the formation of carbon in the bubble trays would seriously reduce the operating time. The positive nature of this separation is evidenced by samples, drawn from the center of the mixing chamber beneath the bubble trays, and which are found to consist of translucent gas oil regardless of the character of charging stock processed. This arrangement not only permits the use of a smaller separating space, but avoids the possibility of forming carbon due to alternate wetting and drying of surfaces; likewise, it induces efficient heat transfer, permitting a higher temperature to be carried at the bottom without coke deposit, which is further inhibited by constant agitation.

The design of the heating element is of outstanding importance in the combination to obtain the desired operating range of temperatures and pressures required of the unit. This element comprises a steel shell lined with fire brick, in which the tubes are disposed vertically

around the circumference of the inner wall. The burner is located at the base of the structure, causing products of combustion to travel upward through the radiant chamber, through the economizer section, passing between the tubes in this section and thence through the superimposed air preheater to the stack. The air for combustion travels around the fire tubes of the air preheater and thence to the burner, which subsequently increases the temperature of combustion. The heat transfer to the oil tubes is effected mainly by radiation, which insures maximum heat transfer at all points under all firing conditions. The small economizer section acts also as a screen for the protection of the tube sheet of the air preheater. In all cases combustion conditions, with practically no excess air, are maintained, and the flame burst temperatures are carried as high as possible. It is practicable to do this, since the heat absorbing surface is so proportioned to the amount of fuel burned that a balance is obtained between the heat withdrawn from the surface and the heat input from the burner which permits only the tube walls to attain a chosen maximum temperature. In other words, the oil which is being pumped through the tubes absorbs heat at such a rate that a high differential is maintained between absorbing surface and the flame proper. There is no tendency for even an intense flame to overheat any one tube, since in this case all of the tubes are equilly spaced at a safe distance from the flame and perform substantially the same duty. At any duty less than the maximum for which the heater is designed, resulting tube temperatures will be reduced well below those permissible.

This type of heating unit has the advantage that it makes possible the heating of the oil to high temperatures economically without overloading any one portion of the heating surface. Furthermore, the reduction of free oxygen in the combustion gases to a minimum prevents oxidation of the outer tube surfaces. By disposing the tubes vertically, the possibility of sagging is eliminated. The heater has structurally interesting advantages, which need not be discussed in this paper.

The unit, as a whole, is remarkably responsive to control, and once stabilized does not exhibit any tendency to become unbalanced. It can be actually put on stream within two hours of firing and is capable of long periods of continuous operation. An examination of the equipment after 600 or 700 stream hours indicates that much longer runs are possible, although at present it is the practice to limit their duration for the purpose of inspection. Adjustments for variation of charge are simple, and it has been found that the presence of water in the charge causes relatively little disturbance in the system.

Perhaps it should be mentioned that the controls of the unit are entirely centralized on one board, and that the operation can be carried out by a single operator, although two are usually employed per shift for the sake of safety and to obtain data which is constantly required for general information.

It will be evident that space does not permit recounting in detail many of the interesting results obtained during the course of this work, and that constant experimenting with operating combinations will furnish new and valuable data in a manner which appears at present unending. Neither is it possible to discuss numerous features whose combinations have been found to be vital to success. It may be said, however, that future work does not contemplate change in equipment which has proven itself beyond question and represents today a new tool the varied uses of which will expand gradually.

The following results are presented to illustrate the performance of the unit under various operating conditions, and to bring out certain facts which have been determined. These results do not represent best operating conditions, but are chosen primarily for the purpose of comparison, and should be distinctly regarded in this light. The yield figures must be viewed as conservative, since it is known that two per cent. to four per cent. additional gasoline yield can be obtained by adequate stripping of the gas.

Fuel consumption for the unit varies mostly with the character of the oil charged, particularly since it is based on fresh oil charged to the plant. In the case of Venezuela crude, the over-all figure for fuel has averaged between five per cent. and six per cent. of the oil charged, and includes both the gas burned and the small amount of oil fuel used in starting up. On gas oil the fuel consumption is of the order of 12 per cent., which appears higher on the charge basis; but, in view of the amount of processing and yields of the order of 60 per cent. instead of 30 per cent., it is about as might be expected. It is felt that the fuel consumption can be still further improved, and provision is being made in new designs to incorporate profitable heat exchange equipment.

Table 1 illustrates the performance of the unit on three runs of approximately the same quantity of charge, under high temperature and different pressures. Run 25 was made at a temperature of 1,071° F., and a heater outlet pressure of 21 pounds while runs 29 and 35 were made with slightly lower temperatures and an average pressure of about 80 pounds.

TABLE NO. 1

Comparison of Venezuela Crude Non-Pressure and Pressure

	Run 25 Venezuela Crude	Run 29 Venezuela Crude	Run 35 Venezuela Crude
Steam hours	400	607	719
Temperature, deg. F. (heater outlet)	1,071	1,046	1,021
Pressure, lb.	21	78	78
Charge, bbl.	19,422	20,124	19,804
Charge, per cent	100.00	100.00	100.00
Yield			
Distillate, per cent	23.71	32.02	26.10
Straight run	700	6.00	5.75
Cracked	16.71	26.02	20.35
Residuum, per cent	69.07	58.64	62.70
Gas, per cent	6.39	10.16	10.60
Tests			
Charge			
A. P. I. gravity	19.2	20.5	19.0
Distillate			
A. P. I. gravity	54.5	56.7	56.6
End point, deg. F.	393	392	364
Color (Saybolt)	Yellow	—2	+1
Residuum			
A. P. I. gravity	11.2	10.0	9.9
Viscosity furol at 122 deg. F	703	297	326

Comparing the runs, it will be noted that increase in

pressure has increased the yield of distillate and improved its quality, particularly with respect to color and treating properties. The production of residuum has been materially decreased and, at the same time, the viscosity has been improved and the gravity reduced.

Mention should be made of the increase of gas in the high pressure runs, which is directly due to more intense cracking and cannot be taken as a dependent effect of pressure. The charge stock in all three runs was the usual grade of Venezuela crude, which varies from 19.2 to 20.5 A. P. I. The crude varies somewhat in gasoline content, as is shown by the percentage of straight run and cracked gasoline in the distillate. Run 35 has been operated to produce a lower end point distillate, which accounts for the difference in distillate yield figures from run 29.

Experience obtained on the relative merits of running at 80 pounds, and pressures of the order of one atmosphere, clearly indicates that better operating conditions are obtained at the higher pressures with regard to the increase in distilalte produced, the decrease and improvement of residuum, and better quality of distillates. These considerations, combined with the fact that the anti-knock properties of the distillates have not been reduced with the increase of pressure, has led to setting aside low pressure operation at least for the present.

Table 2 shows the performance of the unit on Pennsylvania gas oil, California gas oil, and Venezuela crude. In order to obtain comparisons, these figures were taken from test periods of operation during runs. The figures on gas oil represent composite results on various operating periods, and are not as favorable as might be expected from continuous operation under best conditions. They are useful, however, as they are indicative of the order of results.

TABLE NO. 2
Comparison of Runs at Temperatures 1,050-1,100° F.

	Pennsylvania Gas Oil 80 Lb. Pressure	California Gas Oil 80 Lb. Pressure	Venezuela Crude* 80 Lb. Pressure
Charge			
Bbl.	1,070	1,631	1,345
Per cent	100.00	100.00	100.00
Yields			
Distillate, per cent	61.40	53.89	36.40
Residuum, per cent	7.90	18.70	56.00
Gas, per cent	29.20	26.97	6.10
Distillate			
A. P. I. gravity	59.5	55.5	55.4
End point, deg. F	416	412	403
50 per cent point, deg. F	253	283	282
Circulation			
A. P. I. gravity	34.6	28.1	26.3
50 per cent point, deg. F	509	502	514
Charge			
A. P. I. gravity	40.0	32.4	20.1
Initial boiling point, deg. F	430	456	149
Per cent over at 392 deg. F	None	None	8.00
50 per cent point, deg. F	546	516	...
Residuum			
A. P. I. gravity	7.6	7.2	9 3
Viscosity furol at 122 deg. F	280	280	165

*Period taken between 500th and 550th hour of operation.

Both Pennsylvania and California gas oil have been run to coke by returning the bottoms to the charging stock, and under these conditions it was found that yields of distillate could be increased but that gas yields rose out of proportion to the additional amount of distillate made as the bottoms became reduced to coke.

Perhaps the characteristic of greatest interest in high temperature distillates lies in their anti-knock properties, and constitutes one of the chief reasons for operating in this range of temperature. It is generally found that the anti-knock values of distillates increase with operating temperatures. The increase is very rapid up to a certain point, and then less marked. Since the increase in operating temperatures is usually attended by an increase in process gas, the anti-knock values are sometimes associated directly with increased gas production. It has been found that such is not necessarily the case; and, whereas the production of gas may increase indefinitely, the anti-knock values do not.

One of the difficulties of experimenting with anti-knock values lies in the difficulty of obtaining accurate ratings for distillates. For the purpose of this work, the anti-knock ratings have been obtained mostly by The Texas Company rating.[1] In this scale, Pennsylvania gasoline is rated zero and commercial anti-knock gasolines about 25. It has been our experience that these ratings were more comparable between 20 and 30, and it has been the practice to dilute samples with known mixtures in order to obtain ratings within these limits.

An illustration of this method will be seen in Table 3, which shows an analysis of the blend stocks No. 1, 2, 3, and 4; No. 1 being straight run Venezuela gasoline; No. 2 cracked distillate formed at the normal gas rate which is about 10 per cent. of the charge; No. 3 at 132 per cent., and No. 4 at 150 per cent. of the normal gas rate. These samples have approximately the same end point and gravity, and all the cracked samples contain a certain percentage of straight run which has been estimated as shown. These stocks were blended as shown in Table 3, and anti-knock ratings obtained. It will be noted that the anti-knock ratings on the cracked samples themselves are approximately alike; viz., of the order of 33, and that this condition follows with diluted samples. It also shows that with plant straight run gasoline, such as obtained at Bayonne, a mixture of 25 per cent. of cracked distillate with 75 per cent. of straight run Venezuela will give anti-knock ratings for the blended product which compare satisfactorily with commercial requirements.

It will be evident from these results that anti-knock values of distillates are not commensurately increased with gasification beyond the normal rate chosen, which may be considered a desirable limit for operating on this charging stock.

Anti-knock values of distillates depend greatly on the character of the origin of the charging stock. Charging stocks derived from crudes which contain gasolines of favorable anti-knock properties will yield distillates with better anti-knock value than a charging stock obtained from crudes containing gasolines with inferior detonating characteristics. It is also noticeable that anti-knock values are not evenly distributed throughout the distillate. In the case of Venezuela crude, for instance, distillates with low end point of the order of 350°F. are substantially superior to those of 400 end point.

Table 4 shows a comparison between samples of

[1]McCoull, Trans. Soc. Auto. Engrs., 23, 63, (1928.)

TABLE NO. 3
Distillation of Blend Stocks Produced at Varying Gas Rates from 21.3 Gravity Venezuela Crude

Sample No.	1	2	3	4
Gas rate (orifice meter differential)	Venezuela Straight Run	40 in.	70 in.	90 in
Per cent of normal		100	132	150
A. P. I. gravity	53.5	54.4	54.2	52.9
Initial boiling point, deg. F.	112	100	96	102
End point, deg. F	418	393	397	399
Per cent over at 221 deg. F.	19	22	21	20
Per cent over at 284 deg. F.	49	51	51	50
Per cent over at 392 deg. F.	93	94	93	93
50 per cent point, deg. F	286	282	282	284
Per cent recovery	97	95	95	95
Str. run per cent of charge	...	7	7	7
Str. run per cent of dist.	100	25	25	25
Cracked per cent of dist.	0	75	75	75
Anti-knock rating	15	32	33	33

Blends

Sample	Actual Per Cent Straight Run Content				Actual Per Cent Cracked Content	Anti-Knock Rating
5	62.50	50 per cent	No. 1 and	50 per cent No. 2	37.50	30
6	62.50	50 per cent	No. 1 and	50 per cent No. 3	37.50	31
7	62.50	50 per cent	No. 1 and	50 per cent No. 4	37.50	30
8	81.25	75 per cent	No. 1 and	25 per cent No. 2	18.75	28
9	81.25	75 per cent	No. 1 and	25 per cent No. 3	18.75	28
10	81.25	75 per cent	No. 1 and	25 per cent No. 4	18.75	28

Gas Rates

Gas Rate Per Cent Normal	Meter Rates	Oil Circulated Bbl.	M Cu. Ft.	Equivalent Bbl.	Per Cent of Oil Circulated
100.00	40 in.	1104	265	75	6.8
132.00	70 in.	1104	350	99	9.0
150.00	90 in.	1104	397	113	10.2

TABLE NO. 4
Effect of Pressure on Character of Distillate

	15 Lb. Per Sq. In.		80 Lb. Per Sq. In.		100 Lb. Per Sq. In.
A. P. I. gravity	52.7	52.9	52.7	53.8	57.1
Initial boiling point, deg. F	107	104	120	100	98
End point, deg. F	397	380	406	390	371
50 per cent point, deg. F	274	276	300	284	248
Color (Saybolt)	Yellow	Yellow	+7	0	+15
Gum (copper dish)	604	576	...	207	110
Gum (after dilution with equal volume of straight run gasoline)	...	...	...	...	13
Anti-knock rating	32	33	32	33	35

distillate made at 15 pounds, 80 pounds, and 100 pounds per square inch pressure, with approximately constant operating temperatures. It will be noted that the anti-knock values of all these samples are approximately the same, actually showing some improvement in the 100 pound pressure sample. This, however, must be modified by the consideration of the lower end point which would normally give higher anti-knock rating. It will also be noted that the color of the samples has been improved by pressure operation, at the same time the gum content has been reduced. It has been generally found over long periods of operation that pressure of the order of 80 to 100 pounds has reduced the gum content of distillates from 500-600 to 100-200. These results, together with others, indicate that operating under pressures of the order of 100 pounds is not appreciably detrimental to anti-knock values as is sometimes believed.

The treating of distillates formed at temperatures of about 1050°F. and moderate pressures can be accomplished much more readily than with those formed at low pressures and equal operating temperatures. The pressure distillates can be treated with six pounds of acid to make a satisfactory finished product. In this connection, it has been found that about 25 per cent. of such distilaltes requiring no treatment beyond alkali wash and sweetening. This portion of the distillates, which contains the lower boiling fractions, can be readily segregated and the acid treatment confined to the heavier portions, which suffer less from vaporization in refining. This method of handling distillates also results in better anti-knock properties in the finished product.

In the treatment of distillates, it is somewhat difficult to arrive at what constitutes a satisfactory finished product, particularly from the point of view of gum content. The usefulness of the copper dish gum test is generally distrusted, and there is no doubt that the accepted standard imposes unnecessary conditions on distillates of this character.

The purpose of most anti-knock distillates is to find their way into blends of straight run gasoline, and the mere diluting of such distillates effects a very marked reduction on the gum content of the whole. Thus, distillates which may contain gums to the extent of 500 or 600 when diluted to 50 per cent. with straight run, show a gum content of the order of 30 to 60 on the copper dish tests. If, therefore, blends are to be made of the order of 50 per cent. or less of cracked distillates, this phenomenon should be taken into consideration, and the requirement for gums on the cracked blend stocks need not be made so stringent as to require excessive treating, which usually tends to destroy anti-knock values which have been laboriously manufactured. If the industry is interested in obtaining anti-knock values from cracked distillates, progress will be accelerated by an intelligent consideration of allowable limits for certain properties inherent in distillates of this character.

One of the main objectives of the development, which has been briefly reviewed in the foregoing, has been to study the commercial possibilities of producing anti-knock distillates by cracking. In view of the immense scope for research in this field, it seems presumptuous at this time to voice definite conclusions with regard to the most favorable operating conditions required for commercial operations, which must necessarily involve economic considerations as well as technical ones, and must vary greatly with charging stocks available.

Results obtained have justified the belief that cracking low grade charging stocks at temperatures of the order of 1050°F. is practical and economical, even when process gas is valued as fuel. They have also clearly shown that it is feasible to build a cracking unit, at moderate cost, which will operate effectually on widely differing charging stocks and under widely varying operating conditions. This accomplishment is of major importance, as it furnishes a practical and conservative means of establishing an actual criterion of values between results of processing. In its present form, the unit not only satisfies the variable requirements of refinery operation, but constitutes a safeguard to the commercial experiments essential to progress in extending the useful range of cracking.

Bright Stock Manufacture

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Paper Delivered at Tenth Annual Meeting, American Petroleum Institute, Chicago, Ill., December 5, 1929

THE manufacture of bright stock by the contact process is very generally known, and is used with stocks varying through wide specifications. The steam refined stock, after acid treatment, is not neutralized before applying the decolorizing agent, as is the case in the percolating method.

To determine the effect of free acid in the treated stock with respect to the decolorizing and neutralizing value of the clay is the purpose of this series of tests. The steam refined stock was produced continuously in a battery of seven stills from an Oklahoma green crude of the following characteristics:

Gravity, A. P. I.	38.5
Color, in ¼ in. Lovibond cell in 10 per cent water-white naphtha solution	100.0
Basic sediment and water	Trace only

This crude produced 19 per cent steam refined stock which tested as follows:

Gravity, A. P. I.	21.5
Flash, deg. F.	525
Fire, deg. F.	605
Viscosity, at 210 deg. F.	205
Pour, deg. F.	35-65
Carbon residue, per cent.	4.0
Color, in ¼ in. Lovibond cell in 10 per cent water-white naphtha solution	600
Tar (Holde method), per cent.	0.4

Acid treating is the next step involved in the manufacture of bright stock, and sulfuric acid is universally used. This is a source of endless trouble and expense. There are almost as many different procedures of treating as there are refineries handling acid treated stocks.

Temperature, gravity, and strength of acid, number of "dumps," quantity of oil treated, time of blowing, settling time, etc., vary as the steam refined stock varies, and the subsequent method of finishing to bright stock. Some stocks can most economically be treated with 66 Baume acid, while others react best to 98 per cent. acid. In some stocks, the reaction with 98 per cent. acid is so violent that the stock boils over; consequently, a weaker acid only can be used. In general, with 98 per cent. acid, the loss due to sludge is much greater; but a lighter colored acid-treated oil can be obtained which requires less clay to make a given color. Generally, a more efficient treatment is obtained with a definite quantity of acid if the acid be applied in two ar three dumps, settling after each application and drawing off the sludge before applying the next dump. This efficiency, however, is somewhat offset by a slight increase in sludge loss; not being due mainly to more sludge produced, but largely to the steam refined stock drawn off with the sludge in performing two or more clean "draw-offs" instead of one.

TREATING TEMPERATURE IMPORTANT

Temperature of treating is also of prime importance; as the lower the temperature, the more decolorizing value the acid has. Also it is advisable to treat at the lowest temperature consistent with obtaining an intimate contact between the acid and oil. There is, however, a minimum temperature for each grade of stock below which the viscosity of the oil is so great that settling is retarded (in some cases the pepper will not settle) to such an extent that part of the sludge goes back into solution, thereby losing color. This is the manner in which time is an important factor. The reaction between sulfuric acid and asphalt is not irreversible, and after a time the acid treated oil has a tendency to redissolve some of the sludge. Every treater of heavy oils, no doubt, has experienced trouble with his treat forming a "biscuit," i.e., all or part of the sludge after settling rises to the top in a foamy mass. This condition is usually met with in batches treated too hot, or when the sludge remains on the oil too long. It is possible that it is due to a secondary reaction with the liberation of gases forming a light foamy mass. At times, this mass will break and settle of itself; at other times, it becomes necessary to reblow. On the other hand, if the settling period is too short, the loss in drawing the sludge is larger; also in contacting, the oil requires more clay to neutralize the unsettled acid and to remove the suspended sludge and pepper.

Overblowing produces oxidation with a more difficult oil to contact; while insufficient blowing is a waste of acid in that, unless the acid is thoroughly and uniformly mixed, all the acid will not enter into the reaction. This requires more acid than is necessary; or else color is sacrificed.

TREATMENT DETERMINED BY TRIAL

From this partial list of factors, one can readily see that the optimum conditions for treating a given stock can be determined only by trial and by the experience and intelligence of the treater. The best procedure on any grade of stock is to obtain intimate contact, at the lowest consistent temperature, with removal of the sludge produced as quickly as possible. In order to get the best results, some refineries treat their stocks in various percentage solutions of naphthas or kerosenes. There is a large amount of research being conducted along the lines of continuous treating and removing the

sludge by centrifuging. This method of treating has great possibilities for more economical treatment and production of a higher grade of acid treated stock.

The amount of free acid remaining in the treated stock can be controlled to a large extent by blowing. The best procedure of doing this is to check the acidity of the treated stock in the laboratory after drawing off the sludge. If the acidity is high, then additional blowing will in most cases reduce it. With additional blowing, the color has to be watched carefully, for it is possible to overblow to the point where oxidation takes place and the color begins to darken. For this reason, it is not practicable to reduce the acidity to a minimum on some batches, as the increased color will more than offset the advantage gained by a slight decrease in acidity.

The stock selected for this experiment was a sample from plant operation, treated with 98 per cent. acid in two dumps; the first of 14 pounds and the second of 16 pounds. This gave a sludge loss of 30 per cent. and an acid treated stock of 30 color in one-quarter-inch Lovibond cell in 10 per cent. solution.

RESULTS OF EXPERIMENT

In each determination, 1500 cc. of acid treated steam refined stock was used, and contacted 500°F. with 15 pounds of pulp clay per barrel, with results as follows:

	Free Acid in Acid Stock Per Cent.	Color of Finished Bright Stock	Free Acid in Bright Stock Per Cent.
No. 1	0.265	7/8	Neutral
No. 2	0.370	7/16	0.004
No. 3	0.449	9/16	0.004
No. 4	0.582	½	0.003
No. 5	0.738	⅜	0.005
No. 6	1.217	¼	0.009
No. 7	1.575	¼	0.010
No. 8	1.808	Dark	0.014
No. 9	2.127	Dark	0.023

In experiments on No. 8 and 9, the contacted oil was too dark for testing on the Tag-Robinson colorimeter. No. 8, however, showed a very light green cast. No. 9 was much darker, and was beginning to show a noticeable blue cast.

To determine the effect of additional clay on stocks of the same acidity, another series of determinations was made using 20 pounds of pulp clay per barrel:

	Free Acid in Acid Stock Per Cent.	Color of Finished Bright Stock	Free Acid in Bright Stock Per Cent.
No. 1	0.265	1½	Neutral
No. 2	0.370	1-1/16	Neutral
No. 3	0.449	1-3/16	0.002
No. 4	0.582	1⅛	0.003
No. 5	0.738	¾	0.003
No. 7	1.575	⅞	0.002
No. 8	1.808	5/16	0.007
No. 9	2.127	Dark	0.016

No. 9, like No. 8 and 9 in the first series of determinations, was too dark for testing on the Tag-Robinson colorimeter. The color, however, of No. 9 of this series, using 20 pounds per barrel, very closely approximated that of No. 8 of the first series with 15 pounds per barrel.

In the tests, the acidity of the original sample (No. 1) was 0.265 per cent. To obtain the acidity shown in the other samples, the necessary amount of sulfuric acid was added. Upon the addition of acid, there was no change in color, and the determination of free acidity checked the calculated amount added within the limits of error. This check was taken to determine whether or not the acid remained as free acid or reacted with the stock.

CONCLUSIONS

Summarizing the above, we believe the following conclusions are justified:

1. There is a direct relation between the acidity of the acid treated steam refined stock and the color obtained in the finished bright stock. Using a given amount of clay, the color obtained on the finished bright stock is darker as the free acidity of the acid treated steam refined stock increases.

2. The adsorption value of the clay is not 100 per cent. selective. It is generally believed that the clay has a selective adsorption for the acid. From the above, it appears that this is true to a limited extent. However, it will be noted from the above that a bright stock of D color, or better, can be produced and still leave a relatively large amount of free acid in the finished bright stock. The acidity of the finished bright stock will vary in proportion to the acidity of the treated steam refined stock.

3. To produce a bright stock which is neutral from a steam refined stock high in acidity, it is necessary to make a much lighter color than may be desired. For example, a neutral bright stock of seven-eighths Tag-Robinson color is desired. If the acid treated steam refined stock contained approximately 0.265 per cent. free acid, it could be made with 15 pounds of this pulp clay. Whereas on the other hand, if the stock contained approximately 0.370 per cent. free acid, it would require 20 pounds of pulp clay to neutralize completely, with a finished color of 1-1/16.

The above determinations have been conducted using only one kind of clay. However, our experience with several other grades of clay tend to bear out the above conclusions. We have, however, investigated some clays which show high efficiency in neutralizing value but practically no decolorizing properties. In plant operation, the color is approximately 30 per cent. better than that obtained in the laboratory.

Wilcox Plant Offers Some Ingenious Devices

THE Pampa, Texas gasoline plant of the H. F. Wilcox Oil & Gas Company in what is known as the Wilcox or South field, is processing natural gas from the pool which was discovered by the owners. The plant was designed and installed to process 12,000,000 cubit feet of gas which has an average gasoline content of sixty-five hundredths of a gallon per thousand feet, and which gasoline differs from the usual Panhandle area production in that it carries no hydrogen sulphide. The plant is located on the Worley ranch. Production depth ranges from 2900 to 3100 feet.

Natural gas passes into the booster plant, located adjacent to the absorption plant equipment from both the east and west sides of the field. Both incoming gas lines are equipped with double scrubber tank equipment, one scrubber being auxiliary. These scrubbers are manifolded so that in the event of one becoming fouled due to the knocking out of a quantity of oil from the field, the second tank is immediately placed in service while the first is being cleaned.

After scrubbing the gas passes into the booster plant. Ten Bessemer engines and compressors comprise the equipment used, four of which are 165 horsepower, four 80 horsepower and two 50 horsepower. Gas is received at no pressure and boosted to 35 pounds for discharging through the absorption equipment.

Incorporated in the design of the Wilcox booster plant is a rectangular concrete muffler which lies back of the engine room and of equal length of the plant. This duct is five feet deep and four feet wide, covered with concrete on top, but provided with two large manheads, one at each end, so that workmen can easily get into the muffler when necessary for cleaning or repairing.

At each end of the muffler a large tile stack is installed from which the steam and exhaust gases emerge in a steady flow. There are two series of baffles placed in the muffler, installed diagonally to the rear wall which serve to deflect the blast of exhaust gases to each end of the muffler and to each stack. Water is passed into the exhaust lines of each engine at the point where the hot gases leave the machine. The muffler is provided with drains to carry away any water which may not vaporize. During the past two years the device has been in continuous service without inspection. The covering of concrete is kept sufficiently warm that lubricating oil for the plant is placed upon it and kept fluid for easy handling.

Compressed gas leaving the compressor room header is taken through a lube oil trap, where any entrained oil is removed, and then through Braun gas cooler equipment; flowing then through a small surge tank, through a meter, and into the two absorbers. Passing out of the absorbers the lean or residue gas is taken through scrubbers and again metered before being conducted to the carbon black plant of the Western Carbon Company.

The entire absorption plant is Braun equipment. For control of temperatures Foxboro automatic recorder controllers are used.

ELECTRICAL EQUIPMENT

There are no belts or shafts used in the operation of the Wilcox plant. Transfer pumps for handling lean and rich absorption oil are Dean-Hill three-inch centrifugal type, driven by Wait 12 horse power steam turbines. Three pumps are installed, one for lean, one for fat oil, and one being auxiliary. Water pumps are

Interior of power house. The five boilers are under automatic control. Three small gas lines from header take fuel to each of the three sections of Perfecto burners to allow individual regulation

Details of the warning whistle device installed in hot well to warn operators that water level in well is rising

six inch Dean-Hill centrifugals, driven by Wait, 45 horse power steam turbines. The light plant is also driven by Wait steam turbine, 12 horse power. A Burke electric generator, 125 volts, 15 K. W. All exhaust steam from the turbines is conducted through a header line back to a Braun steam condenser and returned direct to the boiler feed water tank. Water from the two 65 foot wells on the plant yard is first treated through a zeolite softener before going to the feed water tank.

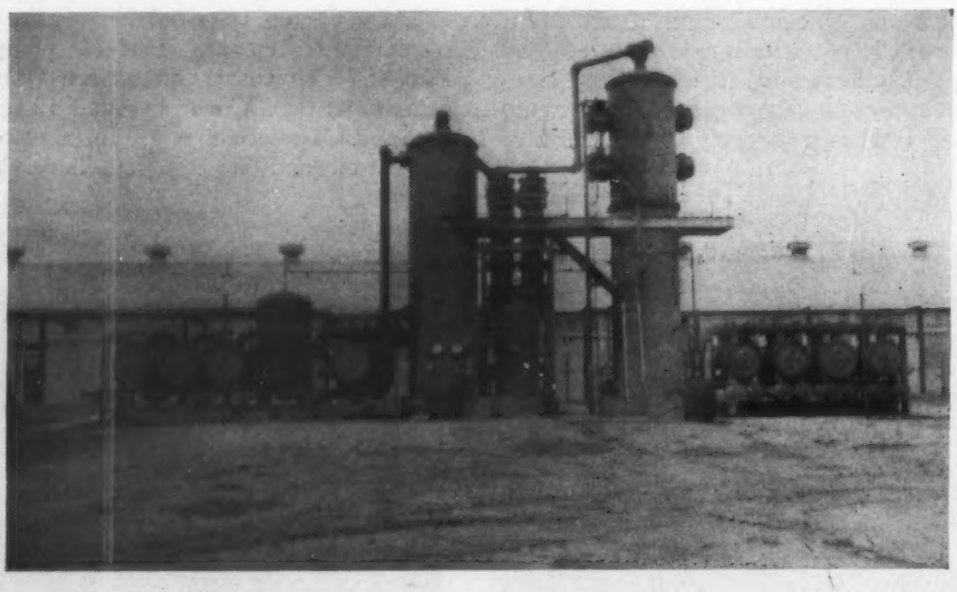
The power house consists of five horizontal return tubular boilers of conventional oil field type but which differ from the usual installation in that they are subjected to accurate automatic control and for this reason do not require the employment of a boilerman. The boiler furnaces or fire boxes are equipped with Sonner Perfecto burners, using three sections to each furnace. Each section receives its fuel through a separate small inlet line, which permits the careful control of flame height. The flame height of the back section, for example, is maintained at lower level than the two foremost flames so that no flame meets the crown sheet.

The rate of firing or gas consumption is controlled by a Foxboro automatic recorder controller, which is actuated by the raising or lowering of steam pressure in the steam header line. If the steam is lowered in pressure, for example, the control device permits more fuel to pass into the burners, increasing the temperature of the fire and subsequently raising the steam pressure to that which is required. Working in conjunction with the gas regulator and controlling the volume of water passing into each boiler, the Copes feed water regulators are employed, on both the boiler water inlet line and the boiler feed pump.

HOT WELL WARNING WHISTLE

The hot well into which all of the water returning from the engine jackets flows continuously, is located in the center of the plant yard and consists of a square concrete basin. From this well the water is picked up by one of the turbine driven centrifugal pumps and discharged over the cooling tower. The well is not exceedingly large and water must be removed from it at about the same rate at which it enters. In the event of the pump losing suction or steam variation troubles, the pump may be stopped or slowed down to the extent that the hot well might overflow with subsequent loss of water and muddying of the plant yard. To eliminate the waste of water one of the men built and installed a warning whistle device.

A rectangular float device is placed in the hot well to hang at a predetermined level. Whenever the water level rises in the well it meets the float and forces it upward. When this occurs a lever is lowered which causes the whistle valve to open. The whistle was home-made of one inch pipe. While this whistle operates with natural gas which is piped from a nearby line, it might also be operated by compressed air, or gas at plant operating pressures. The blowing whistle calls the plant operative's attention to the fact that the danger level has been reached by the rising water in the hot well. This warning occurs 15 minutes before the well will overflow, which has proven to be ample time for either starting the pump again or to get the auxiliary equipment in service.



Exchanger, cooling and distillation equipment laid out in compact and easily accessible design. Booster plant in background

Fluctuating Gas Yield Handled in General Petroleum Plant at Santa Fe Springs

By BRAD MILLS

WITH a capacity of 140 million cubic feet daily, General Petroleum Corporation's combination low and high pressure absorption plant at Santa Fe Springs rates among the most efficient installations on the Pacific Coast and has been designed to operate under varying conditions in a field which is famous for fluctuations.

There are two systems within the one plant—a high pressure and low pressure system, each operating practically independent of the other, and one taking the gas from the old, shallow wells and the other operating exclusively on gas from the high pressure, deep zone wells.

When it was evident that the deep zones were to become major factors, the company started the high pressure system now in operation. It was not completed until after the actual peak of gas production had passed and never actually operated at extreme capacity. When completed, however, it took as high as 120 million cubic feet of gas from the high pressure wells for a short time.

The low pressure system now in use was built around an old plant and still uses many of the installations completed several years ago. New compressors have been installed throughout and other improvements made all through the system.

Some of the installations, as the boiler plant, are common to both the high pressure and low systems, but on the whole the two systems operate independently.

Soon after the plant was completed, both the low and high pressure systems were taking around 125 million cubic feet daily. The gas from the Buckbee and Nordstrum zones was much leaner than that from the upper zones, the maximum plant extraction running about 147,000 gallons. Gasoline content increased slightly as the volume dropped, but a gallon and a half to the thousand was about the best average.

In the high pressure system, no compressors are required. Gas from the field goes through three 8-foot by 20-foot Campbell scrubbers and directly to the high pressure absorbers at about 55 pounds pressure. The Braun type absorbers are capable of working up to 150 pounds pressure.

Pressure on the absorbers is great enough to force the oil into the vent tanks. The combination surge and vent tanks are the company's own design. Each is in reality one tank but operates as two. This arrangement saves time, space and expense.

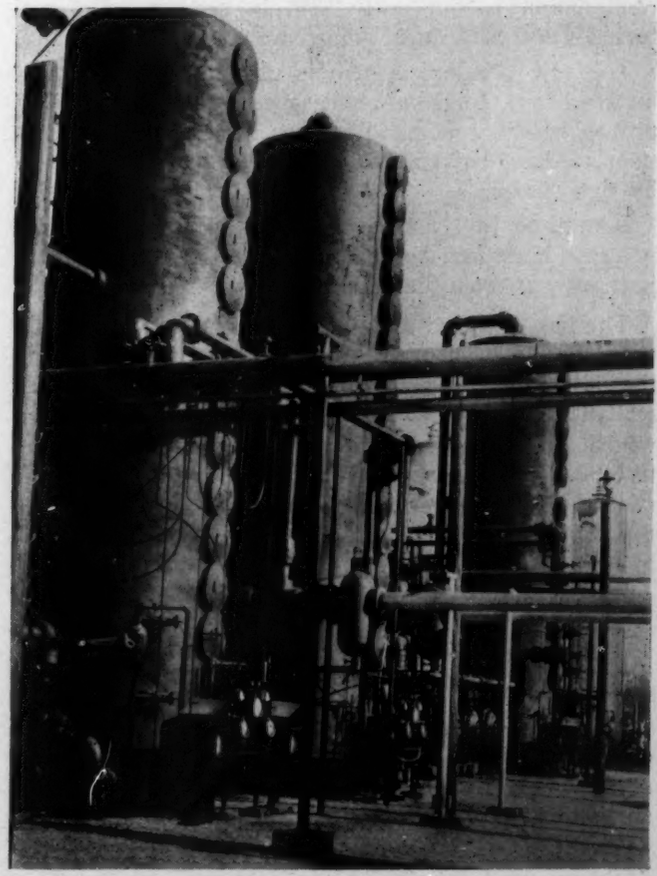
The fat oil then goes through the heat exchangers, picking up some of the heat from the lean oil leaving the stills. It then goes to the pre-heaters before reaching the stills. The fat oil reaches the stills at about 350 F., but the still temperature is kept at about 335 F. Three 10-foot by 30-foot stills are used in the high pressure system. They are of the latest type, two having been built by Braun and one by Badger. The steam pressure to the still is about 140 pounds, while less than 50,000 pounds of steam is used each 24 hours. The saving in steam alone over the old type installation is appreciable.

The end point of the gasoline is controlled by pumping reflux from the rundown de-watering pot back to the top of the still.

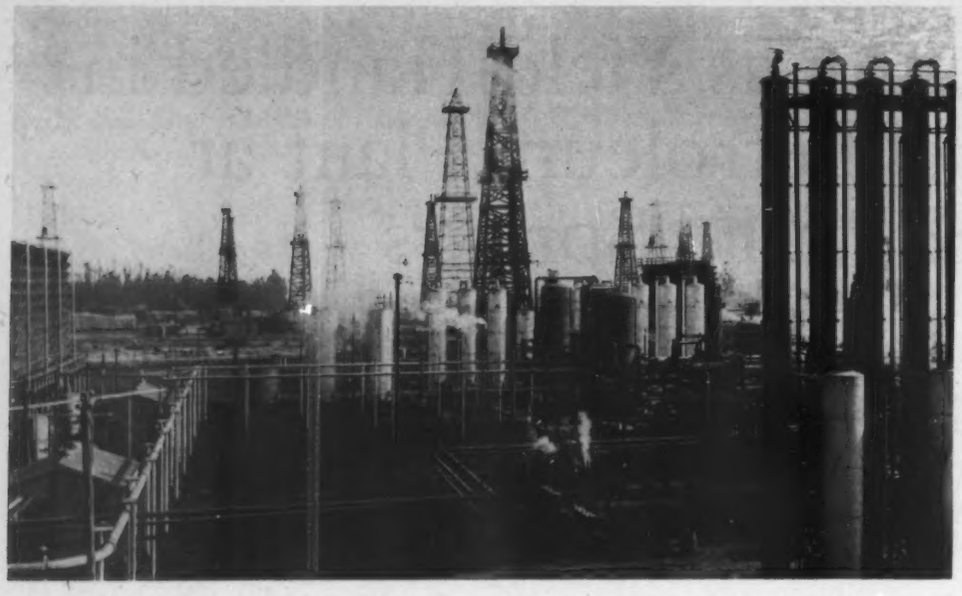
Vapors leaving the top of the still go to the condensing coils in the cooling towers, dropping into the rundown de-watering pot.

Water is circulated in the cooling towers by DeLaval steam turbine pumps, while gasoline is pumped into the storage tanks by the same type of pump, both operating on a single shaft. This arrangement reduces the total pumping cost to a low figure.

The lean oil leaving the stills goes through gravity heat exchangers to the surge tanks. It is then picked



Distillation units each provided with control instrument panel near its base



View of General Petroleum Corporation's Santa Fe Springs plant from the cooling tower

up by the lean oil pump and discharged through the remaining heat exchangers before going to the coils in the cooling towers. From the cooling towers it is returned to the absorbers. All of this process is completed with the initial pressure on the lean oil pumps.

Three 3-stage lean oil pumps of the centrifugal type are used. They will operate up to 250 pounds pressure and are circulating oil at the rate of 560 gallons per minute at 210 Fahrenheit. The fat oil pumps are on the same shaft. This arrangement effects a distinct saving in the circulation of both fat and lean oil. One combination is constantly held in reserve. DeLaval turbines and centrifugal pumps are used.

The low pressure system is using much equipment installed in the original plant several years ago, but has proven efficient in handling gas under present conditions. About eight million cubic feet is being handled by this system.

A total of 14 175-horsepower, Type 80 Cooper compressors have just been installed for handling the low pressure gas from the upper zone wells.

The gas is picked up by the compressors at 15 inches vacuum and discharged at about 38 pounds. It is sent through Braun coolers to the static towers. The installation includes 10 36-inch by 60-foot static towers which were designed a few years ago by General Petroleum Corporation. The gas is sent into the bottom of these static towers, while the lean oil enters at the top. The rich oil leaves the bottom of the towers and is sent to the vent tanks.

The fat oil pumps take suction at the vent tanks and discharge the fat oil through the heat exchangers to the pre-heaters. It then goes to the stills which are the company's own design.

Lean oil leaving the still goes through the heat exchangers, through the cooling coils in the tower to the surge tanks. The lean oil pumps take suction in the surge tanks and discharge to the static towers.

Vapors of the stills go to the primary and secondary dephlegmators, then pass off to the condensers. They are then transferred to the rundown de-watering pot and to the storage tanks in the form of gasoline.

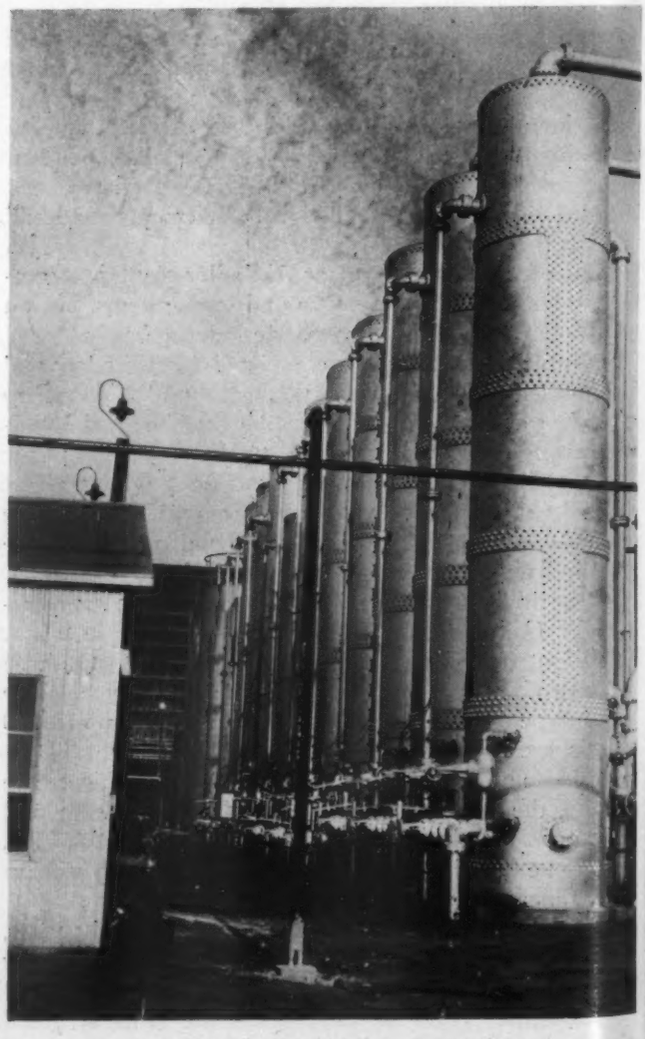
The re-building and enlarging program carried out by the General Petroleum Corporation necessitated several installations which would benefit both the low and high pressure systems. One of the older type Braun cooling towers has been placed in use for cooling the water only.

The boiler plant has been enlarged, now containing two Sterling and eight Hiene 250-horsepower boilers. They operate at 150 pounds pressure.

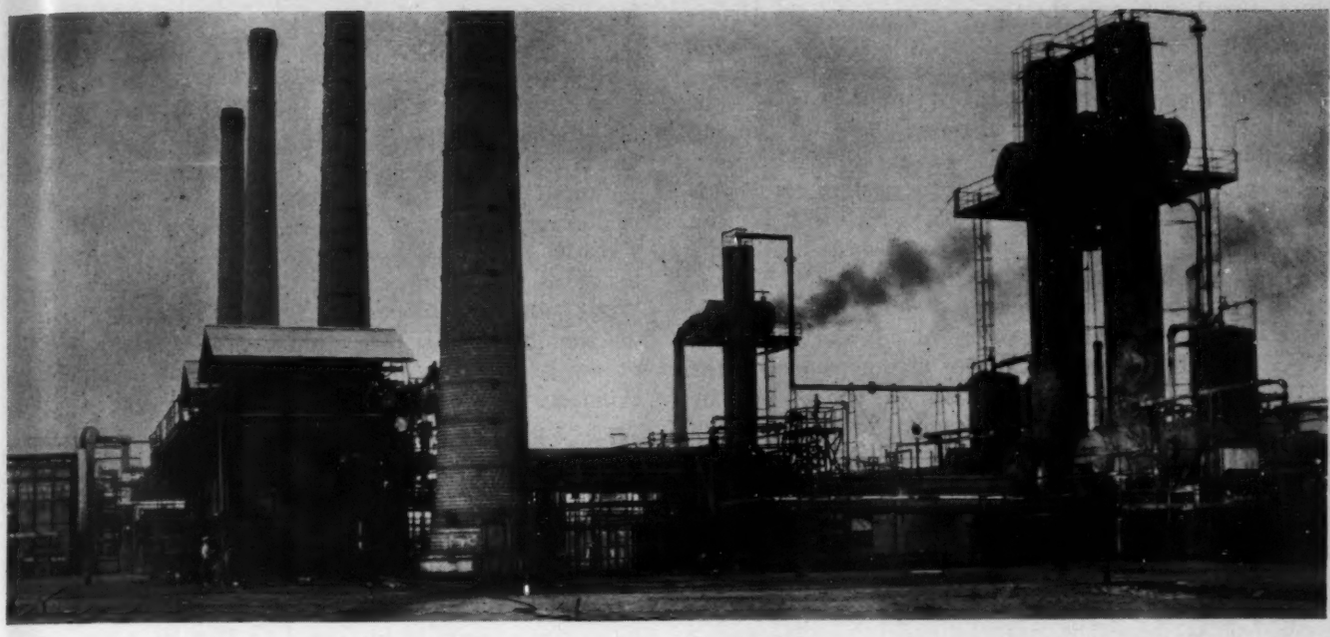
Three late type Braun cooling towers are used for the vapors and oils in both low and high pressure systems.

A careful check is kept on both the incoming and outgoing gas. An elaborate manifold installation has been completed, orifice meters having been adopted as standard equipment.

Much of the dry gas is being marketed, but plans are under way for using a large part of it in re-pressuring the shallow, depleted sands.



Absorbers used in high pressure plant



View of cracking units at Pure Oil Company's Heath, Ohio, refinery which have a clean-out or shut down period between runs of only eleven hours. These units are operated at nearly double their rated capacity of 2000 barrels

Cleaning Time on Cross Units Reduced to Eleven Hours

By GEORGE H. REID

SHUT down periods for cleaning Cross cracking units have been brought to an average of 11 hours at the Heath refinery of Pure Oil Company. These units are charged with topped crude and gas oil, operated at about double their rated capacities, with high temperatures, high pressures and high velocities of flow.

The Cross units at this plant are shut down for cleaning only when the reaction chamber becomes filled with coke instead of such shut-down periods being necessitated because of coke accumulating in the tubes. Because of the high velocity of oil flow through the tubes, but little carbon is deposited in the tube banks and it is thought that the high pressures tend to cause the coke to carry over into the chamber instead remaining on the walls of the tubes. It is, however, necessary to clean all of the tubes with turbines or rattlers, at shut-down time.

The unit needing cleaning is shut down at four o'clock in the morning. Usually by noon they are ready to operate again. In addition to the use of a water blast to wash coke out of the chambers, and several turbines in the work of cleaning tubes, the factor of well trained clean-out crews who understand the value of team work is of much importance.

In describing the clean-out procedure it is perhaps best to follow the system from the time the fires are cut at four o'clock in the morning. When the fires are cut, one of the large charging pumps is shut down. The other pump circulates oil through the tubes until the temperature drops to around 1000 degrees. When the temperature gets to this point the circulating oil is cut out of part of the tubes and allowed to circulate through the preheating tube bank and through the tower.

During this time pressure is dropping from around 900 pounds to 250 or 300 pounds; then the freight line is opened and all of the pressure released. This part of the procedure consumes about one hour.

At five o'clock the plug is removed from the three-inch line leading from the coils into the reaction chamber. At the same time steam is started flowing through the furnace tubes in the same direction as the oil flows through the unit. This steam has a further cooling action and removes all oil or gases from the coils. When the steam is started through the coils, another crew has started a small pump discharging a one-inch stream of water into the top of the reaction chamber. The water stream is under 125 pounds pressure. This water is forced through the reaction chamber and flows through the three-inch line toward the still and shows up at the point where the plug was removed, from which opening the steam passed through the tubes, is flowing.

With this procedure the men are enabled to remove the heads from the chamber in about a half hour, at which time another crew has gotten everything in readiness for pulling the cable.

USE OF THE CABLE

Several methods have been employed in installing the cable but after much experimenting it has been concluded that the best method is to make single loops the full size of the reaction chamber. Three angle irons are welded the entire length of the chamber at equal dis-

tances apart, covering the top semi-circle of the chamber. These angle irons have holes drilled in them about six inches apart, from which 1500 feet of seven-eighths-inch cable is supported by means of small wires. Within five feet of each end of the chamber the cable support is double spaced, putting it in coils three inches apart. Four angles have been welded in the neck of the chamber, spaced equal distances apart, which enables the crew to coil the cable right up to the chamber head. This improvement has effected a saving of about one hour, which was formerly consumed in digging out the two or three feet of hard coke deposited in this chamber neck. When the cable is installed in this manner and with the use of a tractor and a White hoist, the removal of the cable requires from 15 to 45 minutes. The tractor then pulls the cable out flat on the ground where it lays in readiness for reinstallation in the chamber in a few hours.

When the cable is removed the water blasting of the coke in the chamber is started. On the end of the fire hose there is placed a joint of heavy duty pipe which is pushed down to one inch on the outlet end. Extended over this one-inch pipe there is a sort of bayonet which is used to jab the coke loose at the same time the stream of water is playing on it. The water pump has a pressure of 125 pounds per square inch. All of the coke washed out in this manner flows out of the head and onto the roof of the control house. Here a sort of channel is provided to direct its flow to the side of the building where it accumulates for removal. The water passes through a screened flue down to the sewer.

Both ends of the chamber are open during the washing period but until there is a hole over the top of the coke most of it leaves the chamber at the end where the washing is taking place. After about one half of the coke is removed the water washing is stopped for about five minutes while the crew puts on a second joint of pipe which enables them to wash the entire chamber without changing ends. This is necessary since it is almost impossible to handle this heavy pipe with 125 pounds pressure on it on the furnace end of the reaction chamber.

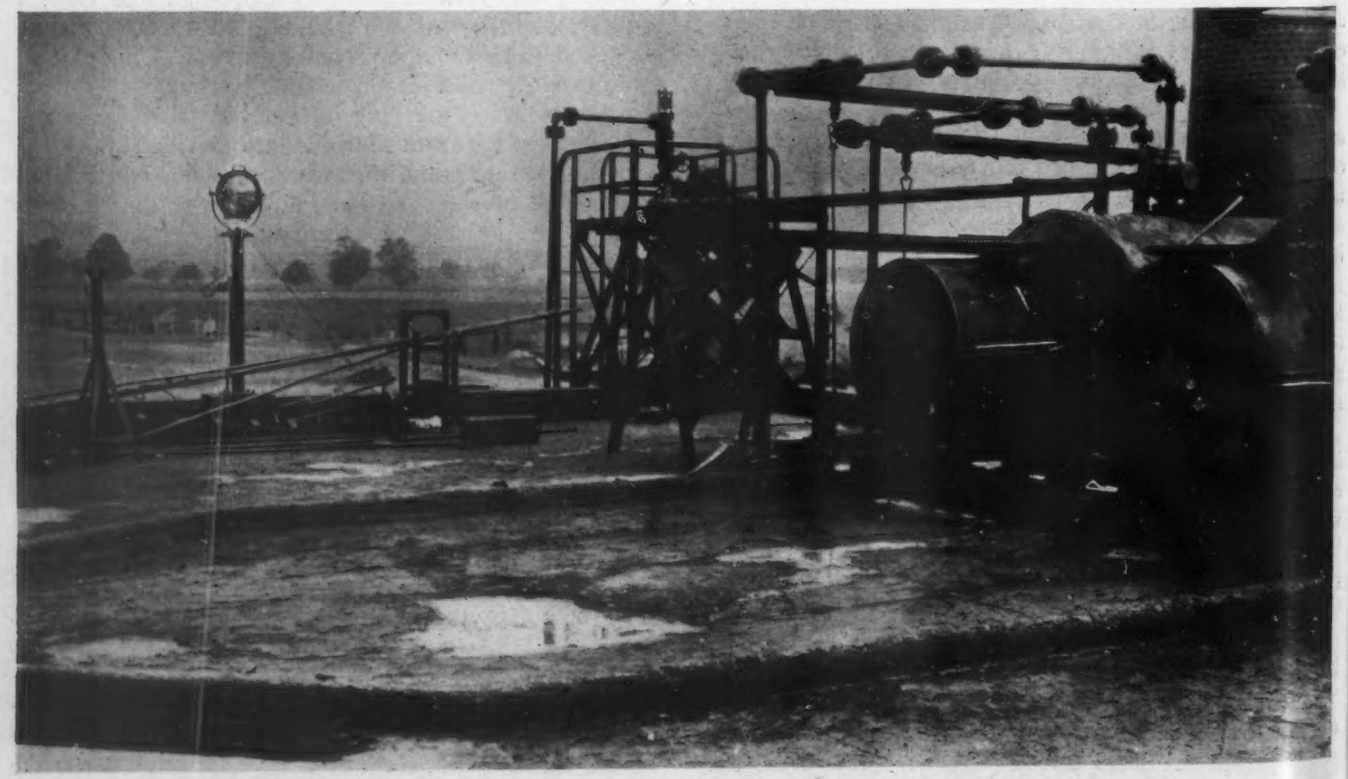
Practically all of the coke is washed out of the chamber through the use of the water blast system. It is only a matter of 30 minutes to one hour for men to crawl inside of the chamber after the water is shut off and shovel out the remaining coke and scrape the sides of the chamber. While the men are in the chamber a blast of air is directed through it to ventilate and cool the chamber. It is thought that all of the coke could be washed out, but the operators feel that water is being wasted after they reach a certain point which is not offset by the time saved by washing.

In this manner the most stubborn chamber may be cleaned and be ready for reinstallation of the cable by eight or nine o'clock. A regular fire line hose is employed for the washing operation and pressure is maintained by a steam pump, size 14 x 12 x 16 inches. The maximum time for the washing is two hours, with an average time of about one hour and 15 minutes.

QUICK WORK SAVES HEAT

Superintendent R. D. McClaran says that in the use of this system the men soon learn from experience the best and quickest manner for removing the coke, but he has found that it requires five men to handle the washing satisfactorily as they must keep the end of the pipe jabbing continually, and at the same time some one must be raking with hoes from each end of the chamber.

The units are being put back on stream from the time the fires are cut in nine to 11 hours, with the average time from off-stream to on-stream being the latter fig-



Coke is washed out of the chambers at this end, and washed through the wide trough as shown to the truck at the side of the control house

ure. This includes all extra down time involved in making miscellaneous small repairs, cleaning evaporators and so forth. Four turbines or rattlers are employed in cleaning out the furnace tubes. This use of additional turbines permits the cleaning crews to finish all of the cleaning operations at practically the same time.

Because of the short length of down time it has been found that it is possible to place the units on stream in two to three hours instead of four to five hours. This is due to the furnace temperatures and the temperatures of the evaporator and tower bottoms all being relatively high. Since the furnaces are fired at 11 to 12 o'clock, after shutting down at four o'clock, the pyrometer will usually show a furnace temperature of 600° to 700° when the fires are lighted. Therefore it is not necessary to fire nearly so slow as it would be if furnace temperature had dropped to 150° to 200°. It is necessary to provide workman with asbestos gloves and with asbestos covered hose in use with the turbines, when the hot apparatus is cleaned. The workmen begin the cleaning operation so quickly after the units are shut down, and finish the job in such a short time, that the system does not have time to get cold before it is again ready for service.

Louisiana Plant Doubled in Capacity

LOUISIANA Oil Refining Corporation recently has rebuilt with double its former capacity, a modern absorption gasoline plant at Cotton Valley, Webster Parish, Louisiana. A total of 30,000 gallons of the highest grade absorption gasoline can now be produced under the new operating conditions.

From each thousand cubic feet of Cotton Valley natural gas 1¾ gallons of natural gasoline can be extracted—a recovery made possible through the use of the recently installed equipment. The same gas shows by standard charcoal test about 1.3 gallons per thousand cubic feet.

The equipment was provided by C. F. Braun Manufacturing Company. All equipment, even storage facilities, is new. The additional volume obtained at the plant may be traced to the multiple system of bubble tray absorbers.

The Braun type of stabilizing unit makes possible the removal of almost all the wild gases resulting in an absorption gasoline with a low evaporation rate in spite of its low initial boiling point.

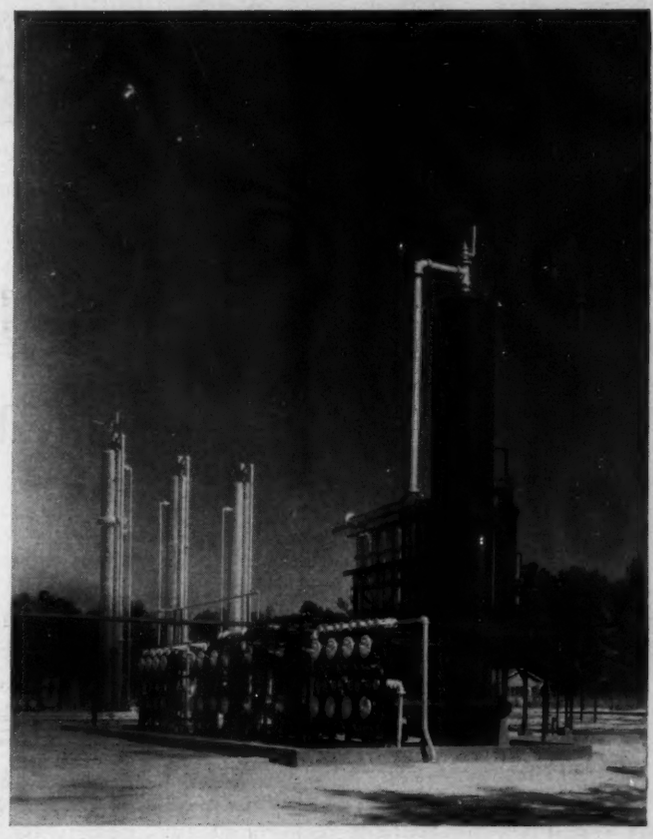
The perfection of the modern stabilizing process minimizes the chances of gas vapor lock in the carburetor which is caused by the rapid evaporation in the carburetor of wild gases unremoved by less modern processes. These gases not treated by a modern stabilizer condense often in mid-morning when the temperature rises and the metal walls of the carburetor become warmer, resulting in a gas lock.

The new plant is thoroughly motorized with complete steam "standbys" to insure continuous operation. The boiler house equipment is in keeping with the remainder of the unit.

Most of the outdoor units, including the battery of absorber towers and storage tanks have been painted with aluminum paint. Concrete walks lead to the various control points. The entire plant is surrounded by a steel-woven fence.

The gas flows under natural rock pressure from the field into the primary mechanical separator, shown in the accompanying picture as the small aluminum pipe at the extreme right. The gas is then forced through the three vertical absorbers, shown side-by-side to the left of the primary separator, but still in the right of the picture.

In the absorber towers a specially refined absorbing oil, a product of the Gas Center refinery of Louisiana Oil Refining Corporation, is sprayed over the gas and



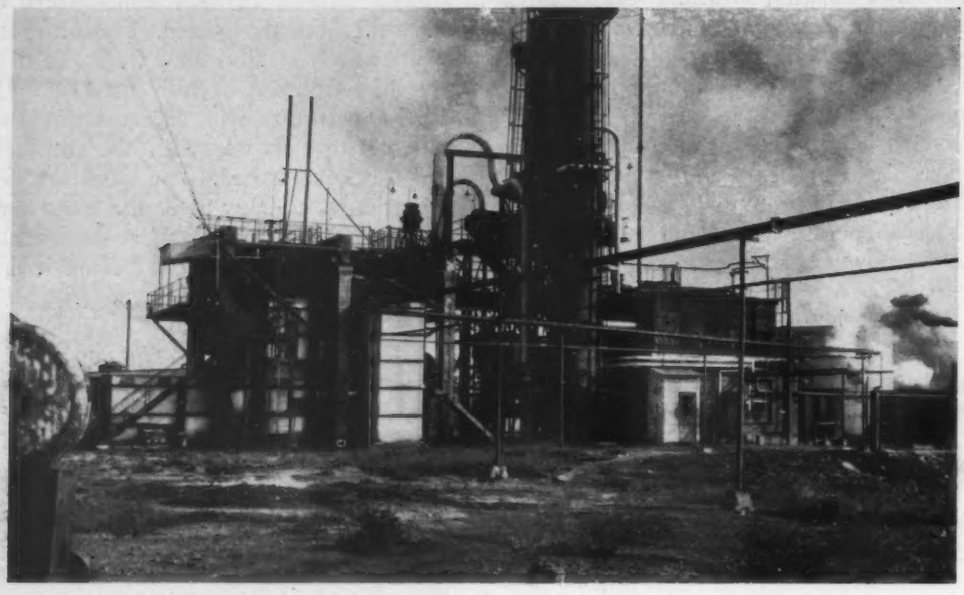
Louisiana absorption plant at Cotton Valley

the natural gasoline content is absorbed from the raw gas. The "fat" oil richened now by the gasoline content, flows to the receiving drum. This is shown as a small black reservoir at the base and to the left of the first absorber tower on the left.

The next operation is the forcing of the "fat" oil through the preheaters and exchangers. Here it is preheated for passing into the still.

In the still the gasoline content of the "fat" oil is vaporized and in its gaseous state it passes into the condensers, shown as the five upright aluminum pipes to the right of the still. In its condensed liquid state the natural gasoline passes into the gasoline receiving drum at the base of the condensers.

The gasoline is then forced through the recently perfected stabilizing unit where the "wild" gases not already eliminated are removed.



Jenkins cracking unit at the Tri-State Refining Company plant which is handling 1,800 *barrels daily of topped Kentucky crude and operating in cycles of three weeks*

Fuel Oil Charged Direct to Burners At Tri-State Refinery

FEW refineries in this country engage in inter-tate commerce when they charge crude to stills, but such is the interesting case with the Tri-State Refining Company with its refinery on the bank of the Ohio River at Kenova, West Virginia and its crude oil storage tank farm high upon the hills across the river in Kentucky. Crude is delivered to the company's tank farm by the Cumberland Pipe Line Company. It is transported by pipe line across the river to the tube still distillation equipment at the rate of 2200 barrels daily.

The Tri-State refinery consists of two Foster tube stills, which are equipped with Graver bubble towers. The plant was originally designed to process 500 barrels of Kentucky crude daily, but later one of the small tube stills and the fractionation and heat-exchange equipment were re-designed so that the plant could handle at least 2000 barrels. A little over a year ago a Jenkins cracking unit was placed in operation to crack around 1800 barrels of topped crude per day.

With the possession of two tube stills, each equipped with efficient bubble towers, the company is able to alternate from one tube still to the other during cleaning periods and thus keep the plant in continuous operation. No. 1 tube still, which is the unit enlarged in capacity some time ago, is the principal distilling unit. It is fired with oil, while the second retort is coal fired, and is in operation practically all of the time doing redistillation work in rerunning pressure distillate, special grades of kerosene and in the production of special close-cut naphthas.

Some corrosion difficulties are met in refining some Kentucky crudes, due to the presence of magnesium chloride. Further, some salt and additional foreign matter are found in the fresh crude. To offset the corrosive atcion of the weak hydrochloric acid formed, this company injects ammonia into the cold crude stream as it leaves the charging pump. It is realized that the action of heat destroys some of the neutralizing effect of the ammonia, but the operators feel that they are stopping the corrosion of equipment at a reasonable cost in the manner which is employed, whereas any change would necessitate installation of new condensing and cooling equipment since the present equipment is made of much brass which can not withstand the action of ammonia.

CHARGING METHOD

Crude charged to the plant first passes through an exhaust steam preheater, Leach type, where the hot exhaust steam from pumps used in the plant preheats the crude to about 190°F. From this heater the oil is conducted to a large horizontal salt settler. It is warm enough at this temperature to drop out practically all of the salt and other foreign matter. The salt settler is equipped with a small knock-out type of tower and a small vapor line which leads into the side of the gasoline fractionating bubble tower.

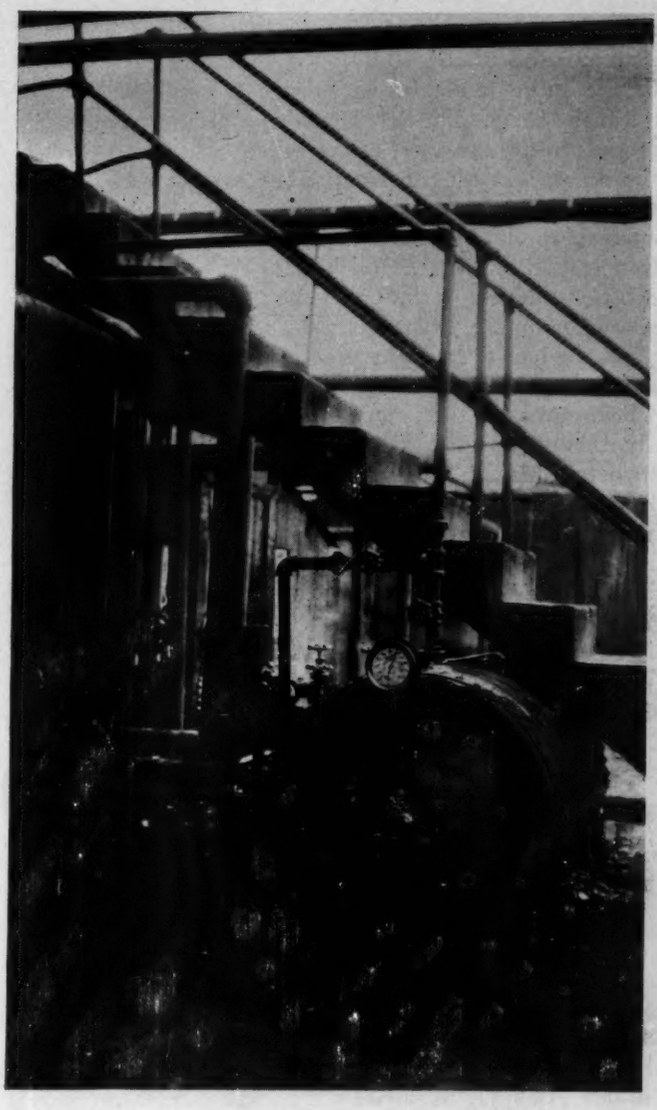
From the salt settler the crude is taken to four Griscom-Russell heat exchangers where sufficient heat is taken from the topped crude to bring the fresh crude

temperature up to 325 to 350°F. From this point the oil goes to a flash tower or separator where a small amount of steam aids in the seperation of gasoline from the crude. There is a series of bubble trays in the upper section of the separator through which the gasoline vapors rise, meeting a spray of wet trim which is controlled by automatic regulation of the trim pumps. The small amount of vapors from the salt settler and the gasoline evaporated by preheat in the exchangers comprises 80 per cent. of the total naphtha content of the crude. This practice relieves the load on the tube still and effectively utilizes the heat contained in the topped crude.

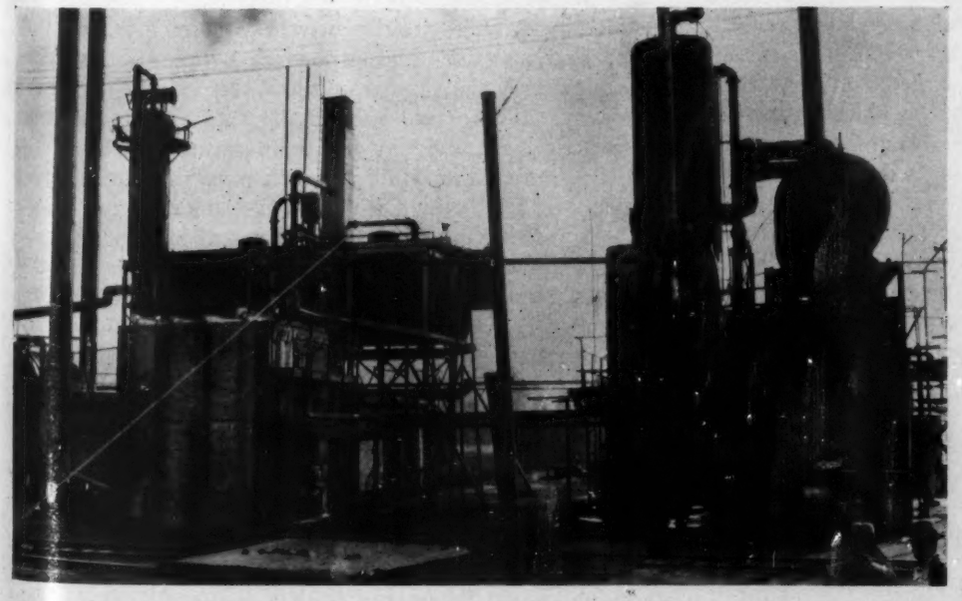
A second pump picks the crude up from the bottom of the separator and discharges through the tube still. Operating temperature of the retort is about 540°F., which is sufficient to effect the vaporization of the remaining gasoline and kerosene.

Leaving the retort the crude enters an elevated horizontal separator from which the vaporized portion passes through a vapor line into the bottom of the first of two bubble towers in series. A stream of light gas oil is removed from the bottom of the first tower which is marketed as Diesel oil. This fraction is readily marketable without chemical treatment. Operating conditions may be changed so that its production is eliminated and kerosene distillate may be withdrawn from this same source. The vapors passing overhead into the bottom of the second bubble tower are fractionated into two streams. Kerosene is taken from the bottom and gasoline is taken over head. At wet trim is employed to control the operating tempareture of this tower. Leach sectional condensers are employed to condense the gasoline stream, followed by a series of tubular type after-coolers which are also employed to cool the bottom streams taken from the two towers.

The lighter stream of gasoline requires no chemical treatment, but the remaining fraction must be sweetened with sodium plumbite solution. A portion of the kerosene is acid treated and some is only sweetened; depending upon the market and specifications required. Pressure distillate from the Jenkins unit is given acid treatment, redistilled and the gasoline sweetened. Gasoline taken direct from the Jenkins unit requires only sweetening. The treating department consists of two 350 barrels agitators and one unit of continuous treaters.



Fuel oil for the still burners is taken directly from the separator through this system. Flow to storage and to burners is regulated by the valves as shown



Crude distillation plant of the Tri-State Refining Company at Kenova, West Virginia. The small unit to the right processes 2,200 barrels of oil daily, removing gasoline, kerosene, and Diesel oil

Fuel oil accumulating in the final separator is taken by pump through the four heat exchangers to cooling coils, and then through to the discharge side of the pump. At this point the operators have perfected a device which eliminates moving fuel oil used to fire the stills to storage and back again to the burners. A small drum type surge tank was installed into which a by-pass line leads from the fuel oil discharge line leading from the pump. A small valve is provided on the line entering the surge tank and another valve is placed

on the line leading to fuel oil storage. Through hand manipulation of these two valves the flow of oil both to the surge tank and to storage is controlled. Fuel oil in the surge tank is held under a pressure about 100 pounds in the tank. It flows directly from the drum to the burners at the furnaces. The system was first installed as a temporary arrangement but has proven so successful that no changes have been made. Through this system warm fuel oil is provided for the burners direct from the residuum separator. It eliminates a second pumping from fuel storage to burners and provides fuel at a constant pressure for the burners. A meter is provided on the fuel line leading to burners which measures the amount of fuel burned in the plant. By this means the accounting department is enabled to determine fuel consumption. It is not necessary to have a separate fuel oil tank for gauging purposes when this system is employed. Since the device is home made about the only expense item of importance is the cost of the fuel oil meter.

Topped crude, containing most of the gas oil fraction is charged to the Jenkins cracking unit, instead of employing an overhead distillate for cracking purposes. Operating the unit at about 100 pounds pressure and about 775°F. temperature and charging the residual oil the average operating cycle is three weeks, charging 1800 barrels daily. No coke is removed from the unit during operation, and at the end of the cycle the coke production amounts to only eight or nine tons. A commercial fuel oil is produced and marketed to such consumers as the steel mills in this district. A portion of the gasoline is removed direct from the unit. The remainder of distilled from the pressure distillate after acid treatment, in the rerun units. Both the tube still redistillation unit and the shell still unit are equipped with bubble type towers with temperature automatically controlled at the top of the tower by means of dry trim cooling sections. These units are also employed in the preparation of special naphtha products of narrow boiling range.

The writer wishes to express appreciation to Commander G. C. Davidson, president of the Tri-State Refining Company, to F. G. Brown, refinery superintendent, and to Mr. Manz, assistant superintendent, for their cooperation in the securing of material as presented in this article.

Pumps, Installing and Operating

By J. S. DUNN*

PUMPS should be installed in a light, dry warm and clean room and should have the best possible attention. The pumps should be accessible for inspection during operation; there should be ample room so an overhead crane, or hoist could be used in lifting heavy parts. Pumps should be installed as near the source of supply as possible. The liquid reservoir should be elevated so that when the suction valve is open the liquid will flow by gravity, the pump will then be self-priming.

Pumps should be installed on substantial foundations. Concrete, brick or stone make reliable foundations. Concrete built up from the ground seems to be the most used. All foundation bolts should be located according to drawings or templates. The erection of pumps should be done by a thoroughly skilled and competent man. The base of the pump must be placed upon the foundation and suitable leveling wedges of iron or steel placed at proper intervals. This is done to support the load solidly without springing.

Alignment of pumps must be accurately and permanently established if successful operation is to be secured. Pumps of large size should be piped with flanged joints and good grade gaskets. On small pumps the screw type of joint is often used. Care should be taken to properly support the suction and discharge piping so that no strain can be put on the pump from either its weight or expansion. Pipe strains are very often the cause of misalignment, hot bearings, warm couplings and vibrations. It is not necessary to take 12-inch and smaller centrifugal pumps off the bedplate while leveling up. Larger sizes should be removed from the bedplate until it is leveled.

*Paper presented at Columbian Gasoline Corporation Foremen's meeting.

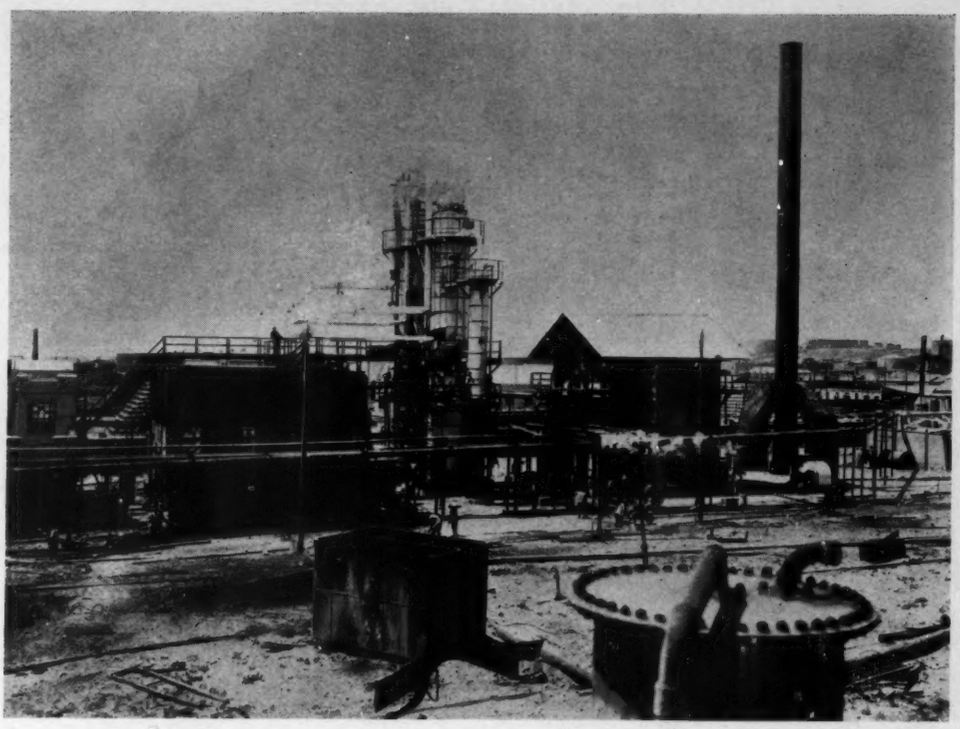
In truing up a coupling, clean off the paint and burrs, use a straight edge and a set of thickness gauges when the couplings are perfectly true on both faces and outside diameter and are of the same diameter. The exact alignment will show the distance between any points on the faces. A straight edge will lie squarely across the rims of both halves at any point. Too much attention cannot be given to the suction conditions of any pumping installation.

Failure to observe different rules relating to the suction of pumps means the failure of the installation.

It has been demonstrated by experiment that the pressure of the atmosphere at sea level is 14.7 pounds per square inch. This experiment was conducted in the year 1643 and was for the purpose of overcoming suction troubles with the pumps at the estate of the Duke of Tuscany. The actual suction lift that can be attained in practice is limited by the temperature of the liquid, the friction of the liquid through pipe and fittings and leakage of air through joints of the suction pipe. There is also a reduction due to velocity and entrance heads. As the altitude increases the atmospheric pressure decreases, resulting in a decrease of the possible suction lift.

All parts of pumps where there is any friction should be well oiled at all times, steam cylinders should be well lubricated, especially before starting. To prevent scoring cylinders; stuffing boxes should be well and evenly filled with a good grade of packing. Do not screw glands up too tight or the rods and plungers will score.

Good metallic packing should be used on steam piston rods where superheated steam is being used. Liquid pistons should be packed with a material that is suitable for the liquid being used.



General view of 1000 barrel pipe still at Asneft State Oil Trust Refinery, Baku, Russia

Application of the Pipe Still for Processing Russian Crudes

By E. GEPPELT, JR.
Graver Corporation

THE comparatively recent general adoption of the pipe still unit for handling various distillation problems of the oil industry in America has given the European refinery an opportunity to obtain maximum yields of various distillates at a minimum cost of labor, fuel and steam.

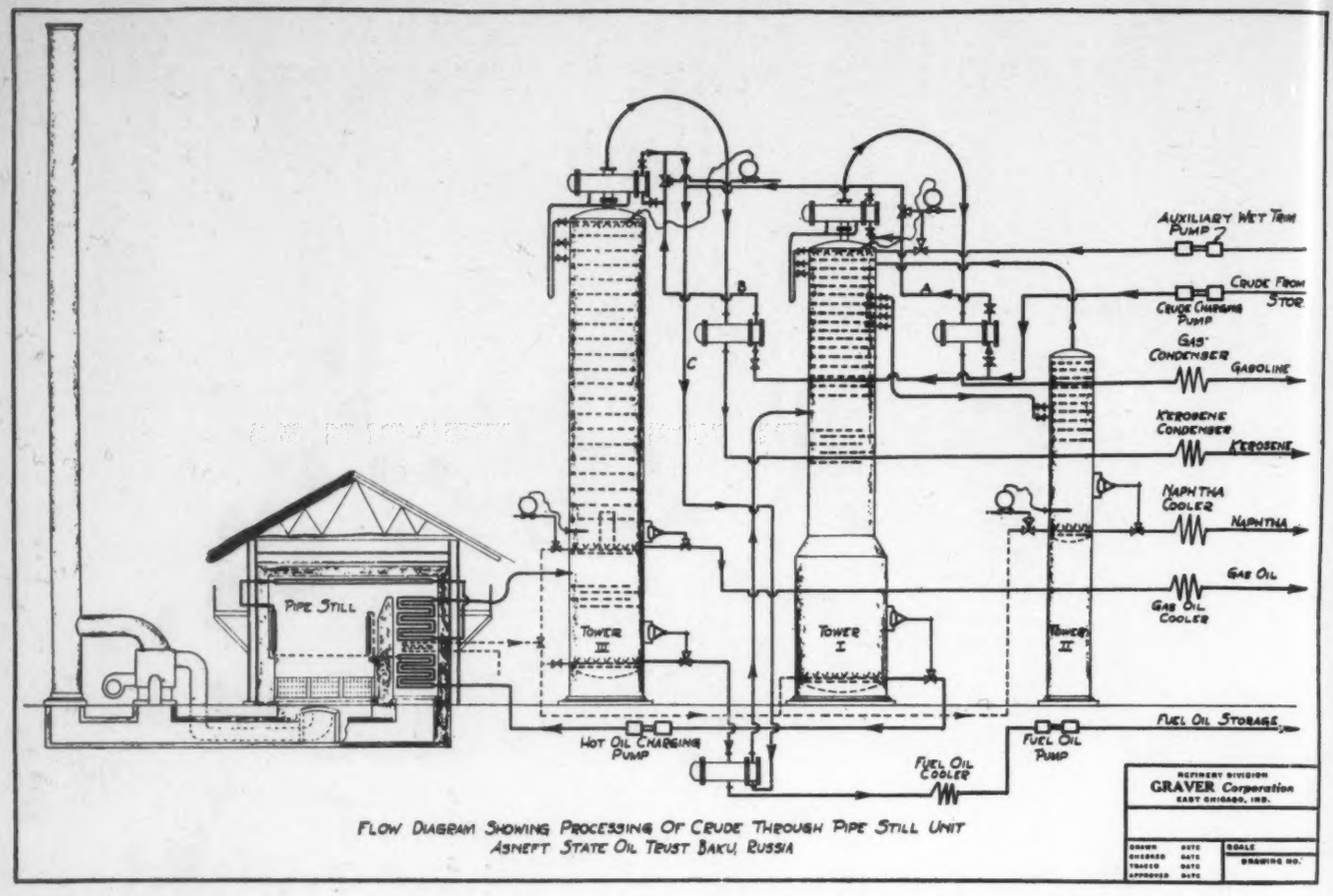
The pipe still at present is recognized as being one of the most economical distillation units, and with the coincident development of efficient fractionating towers it is possible to produce various grades of gasolines and distillates by slight alterations in operating methods, to meet varying marketing conditions.

It is the purpose of this article to give a description of the construction and operation of a 10,000 barrel pipe still unit designed by the Graver Corporation for the Azneft State Oil Trust at Baku, Russia, in whose refinery this unit was installed. The pipe still is designed to produce an ultimate yield of light kerosene distillate from Sourachany or Beeby-Eybet crude. These crudes are produced in the Baku district in Southern Russia and are in character similar to the grade "B" Gulf Coast crudes, inasmuch as they generally contain small percentages of gasoline and are very desirable for the production of lubricating stocks.

Tracing the processing in detail, the reader may refer to the accompanying flow diagram where the crude is shown entering the unit by first passing through the heat exchanging and refluxing equipment in direct proportion to the amount of heat to be removed in each piece of apparatus. The preheated crude is flashed into tower No. 1 at approximately 400 degrees F., which is sufficient temperature to remove as an overhead product the light gasoline and a special naphtha side stream cut. This tower is seven feet in diameter by 45 feet high, provided with 16 cast iron bubble tray sections. The tower top temperature is controlled by an electric pyrometer, which regulates the amount of reflux returned to the tower from the reflux condenser.

A special naphtha with an initial boiling point of 284 degrees F. and an end point of 320 degrees F. and constituting one per cent of the charge, is produced as a side stream and further fractionated in tower No. 2, where all necessary reboiling is accomplished by superheated steam introduced in the base of the tower.

The portion of the remaining crude which is 89 per cent of the total charge, is pumped from the base of tower No. 1 by a hot oil charging pump, and is passed through the pipe still heating element in par-



FLOW DIAGRAM SHOWING PROCESSING OF CRUDE THROUGH PIPE STILL UNIT
AZNEFT STATE OIL TRUST BAKU, RUSSIA

allel flow, where the outgoing stream is raised to 600 degrees.

The pipe still heating element is of maximum radiant heat design, provided with two separate banks of convection tubes and three individual radiant heat sections; two of these sections are located on either side of the combustion chamber and are commonly known as wall tubes, the latter section being located in the conventional roof area. The heating element has a total heating surface of approximately 5800 square feet made up of four-inch nickel chromium steel tubes, supported in the furnace on special alloy castings independent of the furnace brickwork. The still is complete with the Lientz system of flue gas recirculation, air preheaters and a self-supporting steel stack. The hot flue gases leaving the still are returned, in the ratio of two to one, to the combustion chamber and reunited with the combustibles for further combustion. With this system a fuel consumption of 1.35 per cent of the charge is maintained.

Leaving the still, the heated charge enters the stripping section of tower No. 3 where the kerosene and gas oil vapors are separated from the fuel oil and pass up through the fractionating section where the kerosene is removed as an overhead product, the gas oil being removed as a side stream and the fuel oil removed continuously from the base of the tower.

YIELDS SKIMMING

The skimming yields obtained from the Beeby-Eylet crude at the Azneft State Oil Trust refinery will vary within the following limits:

Gasoline	8 to 10 per cent
Special Naphtha	0.8 to 1.0 per cent
Kerosene	35 to 36 per cent
Gas Oil	3 to 4 per cent
Fuel Oil	47 to 48 per cent
Loss	1 to 2 per cent

The light gasoline has an end point of 284° F. as previously stated; the naphtha has an initial boiling point of 284° to 286° F. with an end point of 320° F. The kerosene is of approximately 46 A. P. I. gravity with an initial boiling point of 325° F. and an end point of 530° F. The gas oil produced has a gravity of 40 A. P. I. with an initial boiling point of 527° F. and an end point of 575° F.

All the overhead and side stream products are condensed and cooled in cast iron submerged coil type condensers and coolers located in the conventional type steel condenser boxes, which are supported on native stone piers.

The pump and receiving house is located adjacent to the condensers and coolers in the rear of the pipe still. This building is likewise constructed of native stone, the pump and control room being located on the ground floor, the receiving room located on the second floor; both the pump and receiving rooms are well lighted, having ample steel sash windows.

All operating temperatures are automatically controlled by Brown electric recording and controlling pyrometers, which are located in the control room on a centralized instrument panel board. These instruments enable the operator to control the fuel firing, pipe still temperatures and fractionating tower temperatures from this point.

The reader may note on one of the accompanying pictures the numerous walkways and steel platforms which afford the operator easy accessibility of all operating points in and about the pipe still and fractionating equipment.

Vapor Pressure Vaporization and Boiling

By ALBERT PARSONS SACHS
Fellow of the American Institute of Chemists, Consultant Chemical Engineer, New York City

IN discussions with refiners of petroleum in the last few years, the writer has found that in many cases there was only a hazy, and sometimes an erroneous, understanding of vapor pressure, vaporization and boiling. The occasion has arisen to write an article dealing with the principles of a new vapor phase cracking process, (the True Vapor Phase Process of the Petroleum Conversion Corporation), and the writer feels that it will be best to devote a preliminary article to a discussion of these phenomena.

Let us consider first a pure substance like water. Water has a definite vapor pressure at every temperature and actually vaporizes at all temperatures. We take advantage of this fact every day. When we hang out a wet garment to dry even on a cold day we know that the water in the garment exerts a vapor pressure and vaporizes. If the process of vaporization continues until all the water has been vaporized, we have a dry garment. The vapor pressure of water (and of any pure liquid) is a function of the temperature, and of the temperature only. The vapor pressure of water is given in the following table in terms of millimeters of mercury at intervals of 5°C. to 100°C. and in atmospheres above 100°C. The temperatures below zero represent super-cooled water.

TABLE 1

Temperature °C.	Vapor Pressure mm of mercury
-30	0.38
-25	0.61
-20	0.94
-15	1.34
-10	2.15
-5	3.16
0	4.57
5	6.51
10	9.14
15	12.67
20	17.36
25	23.52
30	31.51
35	41.83
40	54.91
45	71.39
50	91.98
55	117.48
60	148.79
65	186.95
70	233.09
75	288.55
80	354.64
85	433.04
90	525.45
95	633.78
100	760.00

Temperature °C.	Vapor Pressure in atmospheres
100.00	1.0
120.60	2.0
133.91	3.0
144.00	4.0
152.22	5.0
159.22	6.0
165.34	7.0
170.81	8.0
175.77	9.0
180.31	10.0
184.50	11.0
188.41	12.0
192.08	13.0
195.43	14.0
198.98	15.0
364.3 (Critical Point)	194.6

If water is heated to 50°C. it exerts a vapor pressure of 91.98 mm of mercury. Water cannot be heated above 50°C. without causing a corresponding increase in the vapor pressure. In boiler practice it is frequently desirable, in the interests of efficiency and economy, to heat water to temperatures higher than the ordinary boiling point of water; that is to say, above the boiling point of water under atmospheric pressure. This can be accomplished only by the use of increased pressures. To reach a temperature of 180°C. it is necessary to keep the water under a pressure of 10 atmospheres absolute (see Table 1) or 9 atmospheres gage. So long as the vapor is in equilibrium with the water the temperature fixes the vapor pressure.

If, however, we have vapor not in equilibrium with water (i.e. in the absence of liquid water), we can heat it to any higher temperature without an increase in pressure, or even with a drop in pressure if we so desire. Thus the pressure in a boiler is fixed by the temperature reached, but it is possible to super-heat the saturated steam separately and the temperature then does not fix the pressure. It is possible thus to have saturated steam at a pressure of 10 atmospheres absolute at a temperature of 180°C. It is also possible to have dry steam at 180°C. in the absence of liquid at any pressure less than 10 atmospheres.

VAPOR PRESSURE INCREASES WITH TEMPERATURE RISE

When we heat water the following phenomena necessarily occur. As the temperature rises the vapor pressure rises. If the vessel is so arranged as to permit the escape of vapor (steam) the water will be converted ultimately completely into vapor, but if the vapor is not permitted to escape, part of the water will remain as liquid and part will be in the vapor form. So long as any liquid remains the temperature of the liquid will fix

the pressure of the vapor above it. If no liquid is present the vapor may be super-heated and its pressure separately controlled.

We now have a clear conception of the process of vaporization which occurs at all temperatures. The *rate* of vaporization depends partly on the vapor pressure and partly on other external conditions. If there is an atmosphere of air above the liquid the velocity of air currents effects the rate of vaporization profoundly, although the vapor pressure is not affected by the air pressure. On a windy day a wet garment dries more quickly because the vapor formed from the water in the garment is removed by the wind as fast as it is formed. In a closed vessel the vapor remains in the system and as soon as the vapor fills the space above the liquid to the vapor pressure at that temperature no further vaporization occurs.

Vaporization is a process which ordinarily is invisible, merely because most of the liquids with which we are familiar produce colorless vapors. If liquid bromine is poured into a flask or on the ground, we can see the heavy brown vapors forming as a result of vaporization. In vaporization vapor formation is always from the surface of the liquid and not from the interior of the liquid. The velocity of vaporization is increased by increasing the surface from which vaporization may occur.

If the temperature of a liquid is such that its vapor pressure is higher than the pressure existing above it (pressure of the atmosphere, for instance), then bubbles of vapor will form within the body of the liquid and we will have boiling or ebullition. This happens when we heat a kettle of water over a stove. Vapor pressure depends on the temperature only; the boiling point depends on the external pressure only. At normal atmospheric pressure of 760 mm the boiling point of water is 100°C. On Mont Blanc (altitude 4700 meters) the atmospheric pressure is only 417 mm (as compared to 760 mm at sea level); under a pressure of 417 mm water boils at 84°C. Water thus boils at 84°C. on Mont Blanc. It is impossible to boil an egg properly at this altitude because boiling water is not hot enough unless some artificial provision is made to increase the pressure over the water. Pressure cookers constitute such a provision.

In a deep mine where the pressure is higher, water boils at a temperature higher than 100°C. Under a vacuum water will boil at a lower temperature. Under a vacuum of 750 mm (10 mm absolute pressure), water will not only vaporize, but will boil vigorously at about 10°C. (50°F.). This is an experiment which is quite simple to perform. The pressure above a boiling liquid may be due to an external gas, such as the atmospheric air, or it may be autogenously created by the vaporization or boiling of the liquid itself, as happens in a steam boiler or in a pressure still.

CRITICAL TEMPERATURE

As a liquid rises in temperature, the vapor in equilibrium with it rises in pressure. The liquid and the vapor in contact with it are both at the same temperature. It is well known that liquids expand as they become hotter; they become less dense. Vapors and gases, on the other hand, become denser as their pressure increases. At some point the liquid as it becomes less dense, owing to rising temperature and the vapor as it becomes denser with rising pressure, will have the same density and the distinction between liquid and vapor will disappear. This temperature is known as the critical temperature; the vapor pressure at this temperature is also fixed. We, therefore, speak of the critical point. For water the critical point is 364.3°C. and 194.6 atmospheres pressure. Some technologists consider that the cracking temperatures used are above the critical temperatures of the cracking stocks used and that hence no true liquid can exist but at the most a highly compressed vapor in a cracking still.

It may now be recalled that a liquid can be vaporized without boiling. In fact external pressure may be applied over a liquid to prevent it boiling while evaporation by vaporization may be quite rapid. The vapor pressure exerted by a liquid at a given temperature is independent of the pressure of other gases above that liquid. Although water exposed to the air has a pressure of 760 mm of air above it, it still exerts (at 20°C.) its own vapor pressure of 17.36 mm. When we measure the pressure of the atmosphere we measure the total pressure (air and its contained vapor). If in a flask containing water at 20°C. we know that the total pressure is 760 mm then we say that the partial pressure of water vapor is 17.36 mm (determined by the temperature), and that the partial pressure of the air is 742.64 mm. In a mixture of gases or vapors each component exerts its own partial pressure exactly as if the other components were not present. In such a flask the partial pressure of water gas is 17.36 mm, of oxygen about 148.53 mm and of nitrogen 594.11 mm, a total of 760 mm.

CRACKING

We may now consider very briefly what happens in cracking. The liquid petroleum fraction to be subjected to cracking is, unfortunately for the calculations which we might attempt to make, not a simple liquid like water, but is a complex mixture. Thus at a given temperature the vapor pressure is not rigidly fixed but depends on the ratio of vapor space to liquid space and changes as the composition of the liquid changes while vaporization occurs. Similarly the boiling point rises as vaporization proceeds because the composition of the liquid is continuously changing.

Nevertheless it will be profitable to assume for just a moment that the charging stock consists of a pure liquid (i.e. a single chemical compound) and that at a given temperature it exerts a definite vapor pressure, and that at a given pressure the boiling point is fixed.

Cracking is a thermal decomposition of the charging stock. Let us assume that a temperature of 900°F. is necessary for the type of decomposition we wish to bring about. We have a problem quite similar to that of heating water (or steam) to some elevated temperature such as, let us say, 500°F. Since all petroleum materials used as charging stocks for cracking boil at temperatures below 900°F. under ordinary atmospheric pressure, we have two courses open to us: either to create a higher pressure above the heated liquid as is done in a steam boiler, or to superheat the vapor formed by the boiling as we superheat steam.

Both methods have been used. If we create pressure above the heated liquid sufficient to maintain some of it

in liquid form and if we prevent vaporization becoming too extensive (this is accomplished by limiting the size of the vapor space), we have a liquid phase cracking process. A liquid phase cracking process is one in which some of the cracking stock remains as a liquid. But if we do not create sufficient pressure to prevent complete vaporization of the liquid, we must then heat (superheat) the vapor to the desired temperature, and we have a vapor phase cracking process. A vapor phase cracking process is one in which all of the cracking stock exists as vapor.

Each type of process has certain engineering, chemical and economic advantages and disadvantages which will be considered in a later article. But one feature is inherent. A liquid phase cracking process must be conducted under considerable pressure to permit attaining the cracking temperatures considered desirable; a vapor phase cracking process can be conducted at any pressure whatsoever less than that of the liquid phase cracking process. The pressure used at a given temperature for a liquid phase cracking process can be adjusted somewhat by controlling the ratio of the volume of the vapor space to that of the liquid space, but this control is limited; the pressure used at a given temperature for a vapor phase cracking process may be as high as that for the liquid phase cracking process (but cannot be higher) or may be any lesser figure including even atmospheric pressure and vacuum.

The Treatment of Hydrogen Sulphide Cases

By CHAS. AVES, M. D., F. A. C. S.
*Medical Director, Humble Oil & Refining Company**

SOME of the older men in our business tell us of spasmodic cases of men at work being suddenly stricken down in some of the older northern fields, and from their description hydrogen sulphide was the probable cause.

The Mexican oils first brought on a study of these high sulphur petroleums and the toxic cause was first established.

Our experience began with the development of the Texas Panhandle and became serious with the great West Texas development.

Analysis of the gas in the different fields shows the following hydrogen sulphide content:

	Percentage of H_2S.	Parts per Million
Borger Field (Panhandle).....	0.20 to 0.65%	2,000 to 6,500 P.P.M.
Big Lake (Reagan County).....	8.1 to 10.5 %	81,000 to 105,000 P.P.M.
Crane-Upton Counties	4.0 to 14.0 %	40,000 to 140,000 P.P.M.
Winkler County	1.0 to 1.5 %	10,000 to 15,000 P.P.M.
Amount causing death in a few minutes	0.15%	1,500 P.P.M.
Amount causing immediate death..	0.18% to .20%	1,800 to 2,000 P.P.M.

A considerable amount of our study has been made on a typical 160-acre lease in Crane County. Here were 10 wells with a gas analysis of from four per cent to 14 per cent of hydrogen sulphide. A mess hall, bunk houses, and numerous typical houses made up the lease. There were 150 employees, numerous wives, and 16 small children living here. A first-aid nurse was kept in attendance. The gas was very prevalent and a considerable number of men have been unconscious and all have recovered. There has been practically no illness among the families, and in eight months the nurse treated one child for a summer complaint. Respiratory infections were noticeably absent. I mention this as the gas has been blamed for all manner of troubles. The nurse's presence was required mainly for the care of eye conditions that resulted from the gas.

*Safety Congress, Chicago.

DESCRIPTION OF H_2S

Hydrogen sulphide is itself a colorless gas but mixed with petroleum vapors the bluish tinge of the latter makes the gas visible. In very dilute form it has the characteristic odor of rotten eggs. It is considerably heavier than air (Sp. Gr. 1.1912) which causes it to remain near the ground, to fill holes and derrick wells, to flow down ravines and to fill up the space within the fire walls.

It is nearly as toxic (poisonous) as hydrocyanic acid and more so than the dreaded carbon monoxide. As a type it is a toxic gas and locally an irritant.

As seen in the oil field it is extremely toxic and as an irritant, manifests itself mainly in its effect on the eyes. Slightly it causes a dryness of the air passages. And it also prevents the healing of wounds and abrasions.

This irritation is produced by the combination of the gas with the alkali of the body fluids, tears, saliva, blood serum, etc., forming sodium sulphide which is a caustic.

The toxic action is produced on the central nervous system, the brain and spinal cord, to which it is a stimulatn causing a rapid heart action and rapid breathing. This rapid breathing soon results in respiratory failure from the absence of the carbon dioxide in the blood. The carbondioxide is the natural stimulant of our breathing and causes us to breath under all conditions. Its absence causes us to stop breathing immediately. This actior is used in the

treatment of these cases in the administration of carbon dioxide as we will see later.

Concentrations of hydrogen sulphide stronger than 0.1 per cent produce immediate paralysis of the breathing apparatus. The sense of smell is paralyzed in dilutions greater than 0.01 per cent. We have interviewed and examined every man possible, known to have been unconscious from the gas and have yet to find one who has any recollection of having smelled the gas. The sense of smell is certainly of no assistance as a danger warning.

Men have been overcome working at the well; working leeward to the well; working in a ravine where the gas was flowing down like water; working within the fire wall; while gauging tanks, either remaining unconscious on the tank or falling off. Men have been overcome while repairing pipe lines and at work in the refineries and on board ship. A sudden shift of the wind caused the fatal gassing of all the mules in a corral. In fact the gas is a hazard from the time it reaches the surface of the earth until it has been completely cracked and disposed of.

LOCAL EFFECT

Minor wounds, such that men can work with, fail to heal. They simply remain very angry looking and irritated. The constant slight irritation of the sodium sulphide prevents their healing and not until an air-tight dressing is applied or the individual removed from the gas area will such conditions heal. Oil silk, wax paper, or heavy applications of antiseptic ointments will accomplish this.

Eyes react in two different ways. In low concentrations of the gas over a considerable period of time there develops an irritative reaction with a marked inflammation with redness, excessive flow of tears and oversensitiveness to the light. This is the type that recurs and may send the man to the doctor every day or so.

The other reaction occurs when the eyes suddenly come in contact with a very heavy concentration of the gas and usually occurs on the derrick floor. The sensation experienced is explained by the men, that their eyes feel as if suddenly filled with very sharp hot sand. Their suffering is intense and the reaction is extreme with swelling of the lining of the eyes so severe as to often turn the lids inside out.

Recovery of these eye conditions is fairly rapid and usually complete. Rarely an ulcerative condition may develop on the cornea, the color portion of the eye, and this may lead to some permanent defect of the ye.

These severe cases are of necessity placed under the care of a physician immediately. Morphine may be necessary to relieve their suffering. Iced compresses of Boric acid at times combined with an anaesthetic solution usually gives the greatest relief. Sometimes the cold seems to intensify the pain and hot Boric compressses must be used.

I do not believe this severe reaction can be prevented except by remaining away from its possibilities. The first type can, and simply by frequent irrigations of the eyes, three or four times a day with the usual Boric acid eye wash. No sodium salts should be added as is common in practice.

An interesting and yet unexplained condition is that no one, woh has been unconscious from the gas and investigated by us has had any eye reaction at the same time.

RESPIRATORY DISEASES

Inflammation of the air passages is no more prevalent than in a similar community without the gas. I have seen a statement that these infections, particularly pneumonia, are very prevalent in this area. Records and verbal reports from the doctors doing the general practice in these communities do not bear this out.

Some men lost weight and the common complaint was that they slept poorly. They had seen men drop unconscious from this gas and when their sleeping quarters became filled with this odor they were simply afraid to go to sleep.

TOXIC CONDITION

The more acute form of poisoning occurs in a concentrated gas and results in an immediate complete paralysis of the central nervous system. Respiration ceases and the heart stops. Death is immediate.

A second type, slightly less acute, occurs in which respiration stops but the heart continues to beat. This is the common type. A few of these cases will automatically begin breathing and recover by themselves. These might be placed in a third class as still milder than the second.

These mild cases are the ones that recover after the administration of some hypodermic or other simple medication, and for this reason you do find professional men in the fields who believe that this is all that is necessary. The others they simply pronounce dead.

But the great majority will need respiratory assistance or death will result in a short time.

ARTIFICIAL RESPIRATION IMPERATIVE

It is not for his fellow workmen to determine anything about which type it is. Artificial respiration must be started at once and must be given by these same co-workers. The second type comes back, the first does not. This is the discouraging part, they may work a few minutes or a few hours and see natural breathing begin or maybe there never was a chance for him to begin breathing; but who dares say that he may not begin. Personally, I believe that after two hours without ever having any signs of a heart beat with what is at the command of a physician the patient unquestionably will not revive. We see them come back after two, three or four hours of strenuous work; but always with a heart that beats.

Certain of the oil companies have trained thousands of their employes to give the Schaefer-Prone-Pressure Method of Artificial Respiration, and hardly is there a locality where an unconscious man can-

not receive this one chance he has to come back to life. It is his one and only chance and must be started at once. He cannot live without breathing long enough to wait for a physician. There is many an employe in Texas who simply has his fellow workmen to thank for bringing him back to life.

In addition he should be given oxygen—the oxygen from a welding tank if necessary. But preferably oxygen mixed with carbon dioxide with the assistance of an inhalator. As I mentioned before the carbon dioxide is the natural stimulant of respiration, and for that reason is mixed with the oxygen.

Hypodermic administration of drugs is unnecessary and probably harmful. The administration of artificial respiration, preferably with the oxygen-carbon dioxide mixture is all that is necessary.

Recovery, when it occurs, is complete. There is no blood nor body changes. And they recover similar to a patient coming out of an ether anaesthesia.

APPLICATION OF OXYGEN—CARBON DIOXIDE

Artificial respiration should be stopped as soon as natural breathing begins, but the administration of the oxygen-carbon dioxide should be continued for a considerable length of time, oxygen even for hours. These cases will become very restless with the withdrawal of the oxygen, but will remain quiet with its administration.

Again, natural breathing may start, continue for a short time and then again cease. Artificial respiration should be resumed until natural breathing is reestablished. For that reason very careful watching is the rule until they are completely out.

Old rules, made when cases of carbon monoxide poisoning were our gas cases, were that gas cases were to be kept under observation for twenty-four hours with the administration of oxygen twenty minutes out of each hour for twelve hours. This has been kept up simply because it is the rule for all gas cases.

We believe this unnecessary although the oxygen may hasten the elimination of the H_2S from the body faster, and it does give the patient a sense of well being and security.

H. W. Haggard reports a third type of poisoning in which death occurs later from edema of the lungs or broncho-pneumonia. This type occurs when animals are subjected to a diluted gas for a longer period of time and receive the irritating effect in the air passages.

"SHELL SHOCK"

This type has not been seen in our experience. These men receive an immediate toxic (poisonous) dose or receive a diluted gas only intermittently.

Men submerged and inhaling petroleum or its products receive this same irritating reaction and usually, if not always, die.

There is no such thing as developing any ability to withstand the gas. The nearest men come to being accustomed to the gas is that are not afraid of it.

A state of nervous depression is occasionally seen but it is a type of "shell-shock," they are simply afraid of the gas. Often these employes will require removal to a locality far away from the gas and its odor. They can disrupt an entire organization.

Efforts used in combating the hazard of the gas have been educational. The men have been taught what they are handling, its dangers, and what to do in case of poisoning.

Thousands of men have been taught artificial respiration. Bulletins have been issued and the industrial area placarded with information concerning the gas.

The actual treatment of the acute (poison) cases fall on his fellow workman. So for that reason each area and each pipe line station must have its quota of men trained in artificial respiration.

The following instructions are given the men:

(1) Get the patient into fresh air at once.

(2) Give artificial respiration.

(3) Have someone summon a physician immediately.

(4) Give oxygen if available preferably with CO_2 through an inhalator.

(5) Keep him warm.

In closing I wish to add my plea to that of many others that in this form of asphyxia as well as all others, in drowning and in electrical shock, it must be remembered that a considerable number of those apparently dead can be resuscitated. That minutes at the time of rescue are exceedingly precious, for it is then only that respiration can be started again.

The lives of these men are saved by one means alone and that is the immediate artificial breathing by his fellow workmen.

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Informing Workmen of Dangers

By FRANKLIN L. NEWCOMB*

IT is essential that every worker should be informed before entering a dangerous zone that he is entering such a zone and should be informed of the necessary precautions. Since it is impractical to instruct every worker of every dangerous point in the plant and since, even if so instructed, it is unlikely that he would remember them, some means must be devised to call such a condition to his attention as he approaches such a place. Conspicuous signs properly posted at all locations known to be dangerous, warning of the presence of dangerous gas and giving instructions as to the proper safeguarding device to be used, is probably the only effective means of reaching all workers. Provision should be made for posting such signs at all danger points and for removing promptly whenever the hazard no longer exists. Obsolete warning signs left posted promiscuously around the plant probably do more to cause neglect of observance of such signs than any other thing. When the workers know that such warnings are only in positively dangerous locations, the safety precautions advised will be more faithfully observed. A chain, rope or other obstruction which must be unfastened and replaced, with a warning sign attached to such obstructions will assist in calling attention to the warning. However, the replacing of such obstruction after passage must be rigidly enforced, if this is to be effective.

Fresh Air Type Gas Masks should always be worn in all confined spaces inadequately ventilated which may contain dangerous concentrations of petroleum vapors or where the concentration of hydrogen sulphide exceeds one per cent. or that of hydrocarbon vapors exceeds two per cent.

Canister masks may be used in all other locations.

Canister masks should always be adjusted and worn by workers: (a) Gauging or sampling high sulphur crude and unfinished or raw distillate tanks. (b) Drawing water from high sulphur crude and unfinished or raw distillate tanks. (c) In gas exhauster houses and around gas seals. (d) At the agitators when handling distillates from high sulphur crudes. (e) When working on equipment in high sulphur crude or distillate service unless otherwise specifically instructed.

In all other possible danger zones, gas masks should be readily available.

When workers are employed in danger zones on work involving an altitude hazard, safety belts should be worn. This safety belt may be incorporated as a part of the canister mask harness, if desired.

When men are employed in enclosed places, which generally are safe but may accumulate hydrogen hulphide from unsuspected leaks or other causes, a piece of filter paper which has been dipped in lead acetate solution will serve as a warning of the presence of hydrogen sulphide. Such treated paper will darken and even become black in the presence of hydrogen sulphide. Since lead acetate is highly sensitive to hydrogen sulphide, the paper will start to darken before dangerous concentrations are reached. However, lead acetate treated paper cannot be used to determine the amount or percentage of hydrogen sulphide present. If a warning is received through the darkening of this indicator, gas masks should immediately be adjusted and worn until the source of supply of the hydrogen sulphide is removed and the atmosphere again found to be free of hydrogen sulphide. It is advisable, in such cases, to have samples of the atmosphere analyzed to determine the amount of hydrogen sulphide present.

Oil men employed in taking gauges and samples on tanks containing sour crudes or untreated distillates should be provided with canister gas masks, should be properly instructed as to their proper adjustment and should be properly instructed in the Schaefer-Prone-Pressure method of artificial respiration. Mechanical measuring should be used wherever possible and tape gauges should be taken only when necessary for final check. At least two gaugers should always be present when working on crudes and untreated distillates. Both should at all times wear their harness and canister ready for instant use. Both should put on their face pieces and adjust them properly before one leaves the ground to gauge or sample the tank. The second man should remain at a safe distance, but in such a location that he can clearly observe the condition of the man who is doing the gauging or sampling. In case the man doing the gauging or sampling is overcome, the second man should immediately go to his assistance, close the gauging hatch, remove the prostrate man from the danger zone, remove the gas masks, start artificial respiration by the Schaefer-Prone-Pressure method, if necessary, and at the first opportunity summon medical aid. Whistles supplied to gaugers may often be of assistance in attracting attention and thereby securing a means of summoning medical and other aid.

In remote locations, such as large tank farms or other isolated locations, it is advisable to have three men present during gauging and sampling operations in order that medical aid can be summoned while artificial respiration is being given. The third party present might be the watchman where one is employed.

When gauging or sampling, the gauger should stand on the side of the hatch from which the wind is blowing so that gas will be blown away from him. This may mean that at times he must stand on the tank roof. Precaution should be taken that the roof is strong enough to hold the weight, or independent platforms should be installed to permit the gauger getting in this position.

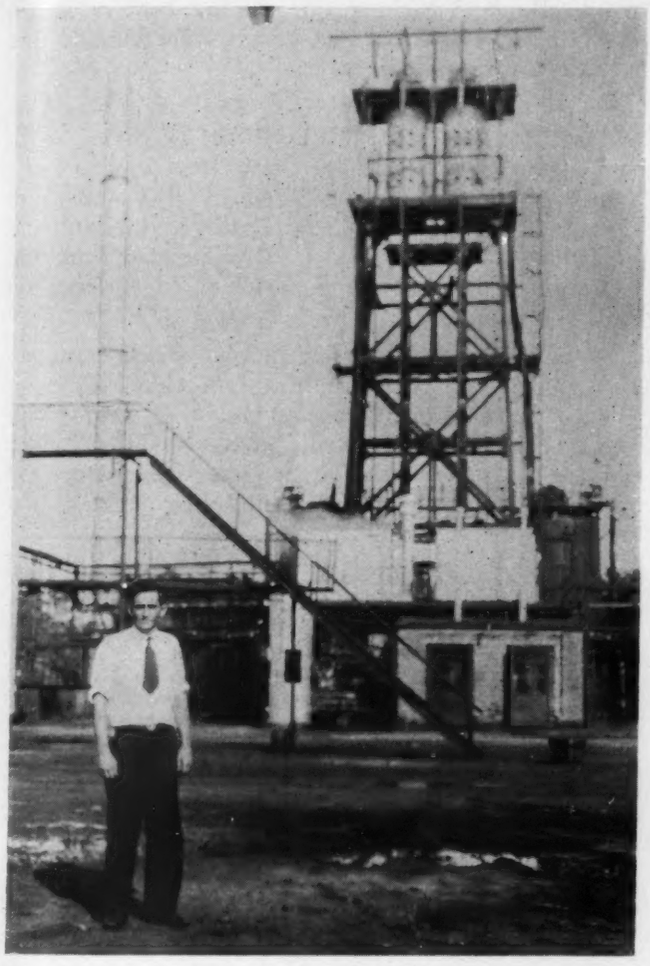
A guard rail should be placed around the hatch in such a manner as to prevent a man from rolling off should he become unconscious. Under no circumstances should a gate be installed which will in any manner delay the removal of an unconscious man.

The railing on each side of the tank stairway from top to bottom should be arranged in such a manner as to prevent a man from rolling off the side of the stairway in case he should roll down when unconscious.

*Safety Inspection Division, General Engineering Department, Standard Oil Development Company. Extract from paper read before National Safety Council.

DEALING IN PERSONALITIES

By GEORGE REID



R. E. Allison, assistant superintendent, Louisville Refining Company, in charge of the cracking department

The two Dubbs cracking units at the Louisville Refining Company, Louisville, Kentucky, after five years owe much for their present state of excellent repair and condition to R. E. Allison, assistant superintendent in charge of the cracking department under C. A. Jouett, general superintendent. In the picture Allison is shown standing before one of the cracking units. The wet spots shown on the ground come from a rain fall which stopped only long enough for the picture to be taken. No oil spots are permitted on the refinery yard.

Allison had much to do with the perfection of the flashing system employed at this plant for handling heavy residues from the cracking units and the utilization of this material as fuel for the distillation system, including skimming, rerunning and cracking units. Fractionating the material vaporized in the flash chambers results in nice yields of a premium low cold test furnace oil and a lighter stream which yields 70 per cent. gasoline.

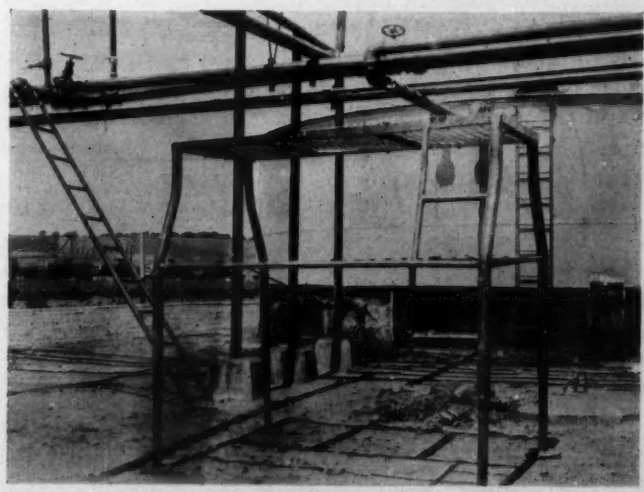
By skimming gasoline and kerosene off the crude, then cracking the topped crude in the Dubbs units, the Louisville Refining Company restricts its products to gasoline, kerosene and coke, with small quantities of premium grade furnace oil.

WHEN two men, or more, need a scaffold, in order to reach jobs occurring overhead at the Cushing, Oklahoma, plant of Empire Refineries, Inc., they carry it with them. There is no delay caused by waiting for construction of wooden scaffolding at the side of tanks, or under overhead lines, or at any of the other numerous places about the refinery yard which may need occasionally small repair jobs. Neither is it necessary for the employe to perch upon the top rung of a ladder and risk a fall while making repairs of the kind. The "safety table" is a permanent and mobile scaffold, and it is a labor and time saving device of importance, as well as being "safe."

The accompanying photograph shows the details of construction of the safety table and one of the purposes for which it is used. The table itself is a product of the welding shop and is fabricated mostly from scrap pipe found on the refinery yard. Angle iron is used around the circumference of the working platform, which is covered with Irving Subway Treat, instead of the usual planking. Welded rigidly together the table has the advantage of being sturdy, amply strong for supporting as many men as may be necessary, and very light in weight. The Subway Treat of steel, used as flooring, reduces slipping. The table top is 3 by 6 feet in diamensions.

The table legs are made of 2½-inch pipe and support the table 6 feet above ground. Connecting supports tying the table together are of 1-inch pipe, as is the ladder section as shown in the illustration. This is built into the table for the obvious reason of making easy ascent and descent to and from the table without any danger of sprains, etc.

The table legs are adjustable, to a distance of 1½ feet. With this feature the table may be at any convenient height from 6 feet to 7½ feet above ground. The adjustable feature is made possible by using 1½-



Adjustable "Safety Working Table," at Empire Refineries, Cushing, Oklahoma, plant

inch pipe at the bottom, which is perforated with small holes at equal distances, through which the bolt is inserted as shown in the picture. Each leg is provided with a large flat disc of metal which acts as a base resting upon the ground and prevents the legs working into the earth and throwing the table out of level. The adjustable feature of the legs makes possible the use of the table on rough or uneven ground.

The safety table finds many uses about the plant. Rundown tanktops, all overhead steam, water and oil lines are within easy reach. Tanks may be painted with greater ease. The table weighs approximately 150 pounds. Two men can carry it from place to place with ease. Sides of buildings, still settings, overhead valves and fittings, and much other equipment about the plant yard installed at a height of from 6 to 10 feet above ground is easily accessable through the use of the safety working table.

In the same picture is shown one of the iron ladders made by the welding shop and this plant, fabricated of old piping. These ladders are placed at every valve in the yard which is located above ground, as part of the company's safety program. In addition to the feature of safety, they are time and labor saving, since every valve is permanently provided with the necessary means of approach and no time is wasted in the search for a lost ladder.

N. P. A. NAMES DEPARTMENT PERSONNEL

Department personnel of the National Petroleum Association has been approved by the board of Trustees, which met in Pittsburgh, November 14. In announcing the personnel, E. M. Lyons, president of the association, wrote:

"The work of the association is being intensely organized and we hope you will keep a copy of this department personnel bulletin in a convenient place, where it can be resorted to in connection with any problems in which the association is interested or can be of service to your company."

The several departments, with appointments for each, follow:

Economics, Accounting and Statistics—T. J. Hilliard, trustee; Councillors: M. A. Brewster, Pennzoil Company, Oil City Pennsylvania; S. J. Brill, Kendall Refining Company, Bradford, Pennsylvania; Clarence J. Fox, Emlenton Refining Company, Emlenton, Pennsylvania; H. A. Gidney, Gulf Refining Company, Pittsburg; J. E. Johnson, Waverly Oil Works Company, Pittsburgh.

Legislation and Litigation—Sheldon Clark, trustee; Councillors: Frank R. Coates, Crew Levick Company, New York; M. F. Cowden, Pennsylvania Oil Products Refining Company, Warren; William A. McAfee, Standard Oil Company of Ohio, Cleveland; Samuel Messer, James B. Berry Sons Company, Oil City, H. F. Stone, Gulf Refining Company, Pittsburgh.

Manufacture—P. S. Tarbox, trustee; Councillors: Earl E. Bown, Kendall Refining Company, Bradford; D. W. Hovey, Waverly Oil Works Company, Pittsburgh; Harry R. Lewis, Conewango Refining Company, Warren; F. J. McGraw, Oil Creek Refining Company, Titusville; J. B. Northrum, Ohio Valley Refining Company, St. Marys, West Virginia.

The division of manufacture also has company memberships in each of the refining centers, Bradford, Butler, Oil City, Pittsburgh, Warren and one for West Virginia.

Under manufacture thre is a division of scientific research, of which G. C. Davison is trustee, with councillors G. D. Brandt, Crew Levick Company, New York; J. S. Harrison, Standard Oil Company of Ohio, Cleveland; Dr. J. B. Rather, Standard Oil Company of New York; C. R. Wagner, Pure Oil Company, Chicago; W. S. Zehrung, The Pennzoil Company, Oil City.

Standards and Tests—Earle M. Craig, trustee; Councillors: F. W. Beth, Franklin Creek Refining Company, Franklin; McLean Houston, United Refining Company, Warren; E. M. Keely, Crew Levick Company, Philadelphia; R. S. Osterstrom, Pure Oil Company, Chicago; Frank Philippbar, Kendall Refining Company, Bradford.

Membership and Relations—W. T. Holliday, trustee; Councillors: John S. Cordell, Cities Service Refining Company, Boston; O. D. Donnell, Ohio Oil Company, Findlay; John F. Flynn, Ohio Valley Refining Company, St. Marys, West Virginia; H. W. Logan, United Refining Company, Warren; A. C. Woodman, Richfield Oil Corporation, New York.

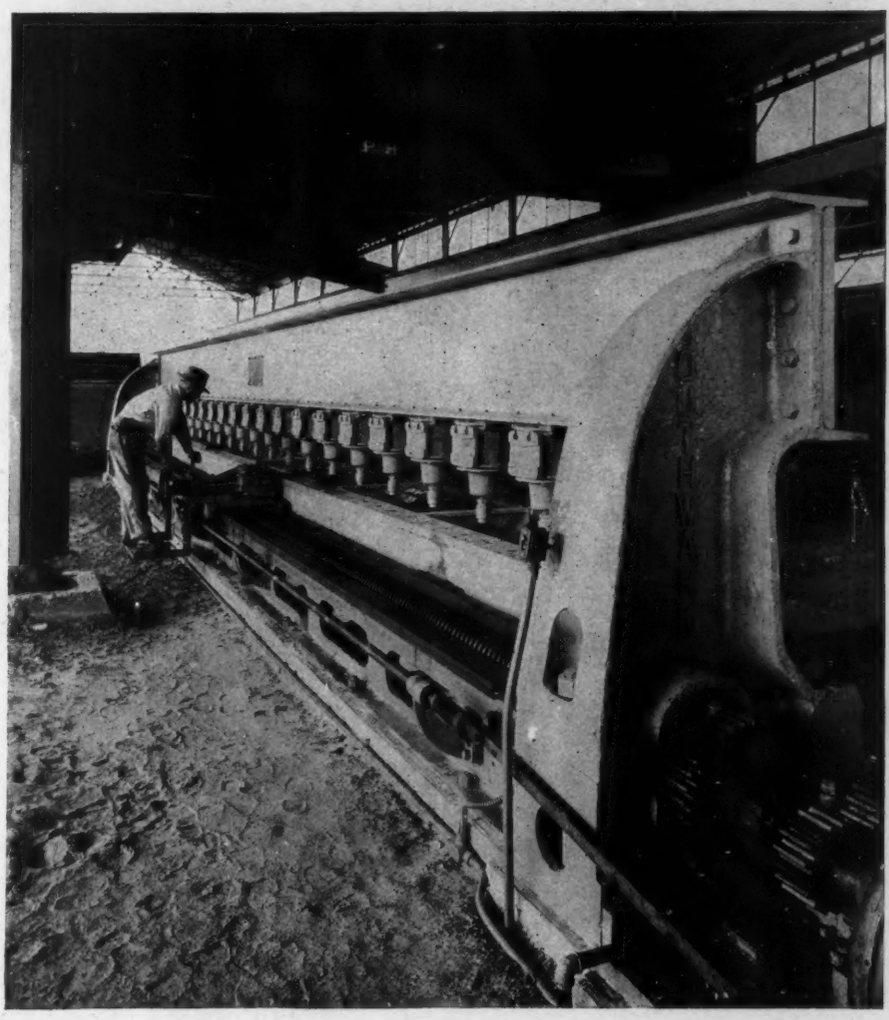
Trade and Commerce—N. H. Weber, trustee; East Coast Group, C. G. Sheffield, Standard Oil Company of New Jersey, chairman; Councillors: Axtell J. Byles, Tide Water Oil Company, New York; J. M. Carnes, Sinclair Refining Company, New York; Frederic Ewing, Standard Oil Company of New Jersey, New York; Harry D. Freuaff, Cities Service Company, New York; J. Howard Pew, Sun Oil Company, Philadelphia.

Pennsylvania—West Virginia Group, A. W. Scott, chairman, Empire Oil Works Company, Oil City; Paul Blazer, Ashland Refining Company, Ashland, Kentucky; A. M. Kiester, Ohio Valley Refining Company, St. Marys; James Lewis, Bradford Oil Refining Company, Bradford; L. L. Long, Waverly Oil Works Company, Pittsburgh; Harry W. Schmidt United Refining Company, Warren; A. B. Weingard, American Oil Works Company, Titusville.

Central States Group, General H. C. Smithers, Indian Refining Company, Lawrenceville, Illinois, chairman; Councillors: H. B. Carpenter, Ohio Oil Company, Findlay; F. T. Cuthbert, Solar Refining Company, Lima, Ohio; U. deB. Daley, Shell Petroleum Corporation, St. Louis; E. W. Edwards, Paragon Refining Company, Toledo, Ohio; W. E. Smith, Standard Oil Company of Kentucky, Louisville.

Traffic and Transportation—Frank B. Fretter, trustee; East Coast Group; Councillors: L. H. Benner, Standard Oil Company of New York, New York; C. B. Ellis, Gulf Refining Company, Pittsburgh; W. A. Hamel, Cities Service Refining Company, Boston; J. M. O'Day, Sinclair Refining Com-

EQUIPMENT
back of good service at *Wyatt's*



36-FOOT PLATE PLANER

FOR maintaining a quality of work equal to that produced anywhere in the United States the Wyatt Metal & Boiler Works has placed in its Houston plant a number of machines destined to be of great value to the oil industry.

One of these machines is one of the largest plate planers in the country. It is 37 feet in length between housings and takes a 36-foot sheet up to 1½-inch plate. It reverses automatically.

In subsequent advertisements Wyatt's will describe other equipment of interest to the oil and gas industry. Watch for these advertisements and familiarize yourself with the equipment of the South's greatest fabricating shop. Plants at both Houston and Dallas. Let Wyatt's figure on your next job.

WYATT METAL & BOILER WORKS
DALLAS *Capital $1,000.000* HOUSTON

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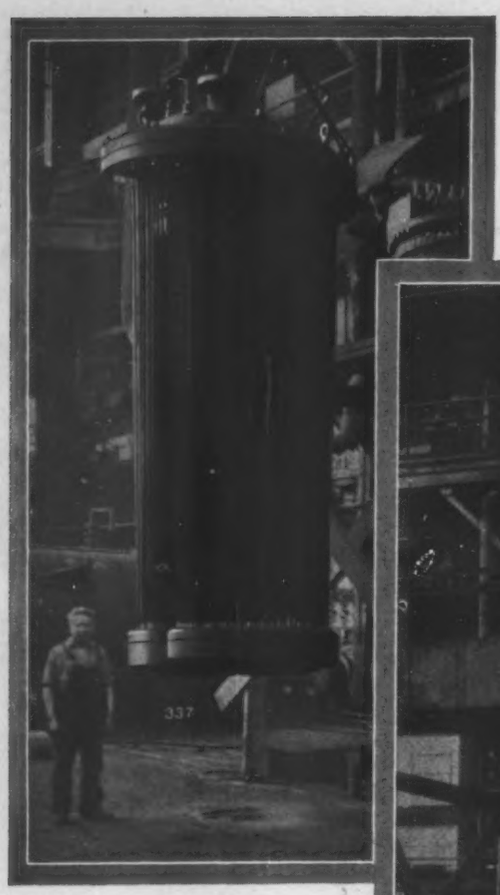
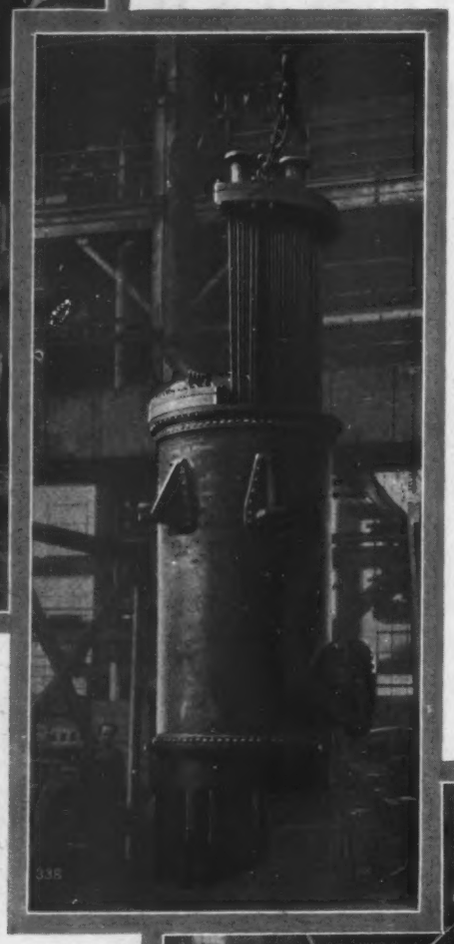
DECREASED

A New Design Vapor Condenser for Vacuum Distillation of Lubricating Oil.

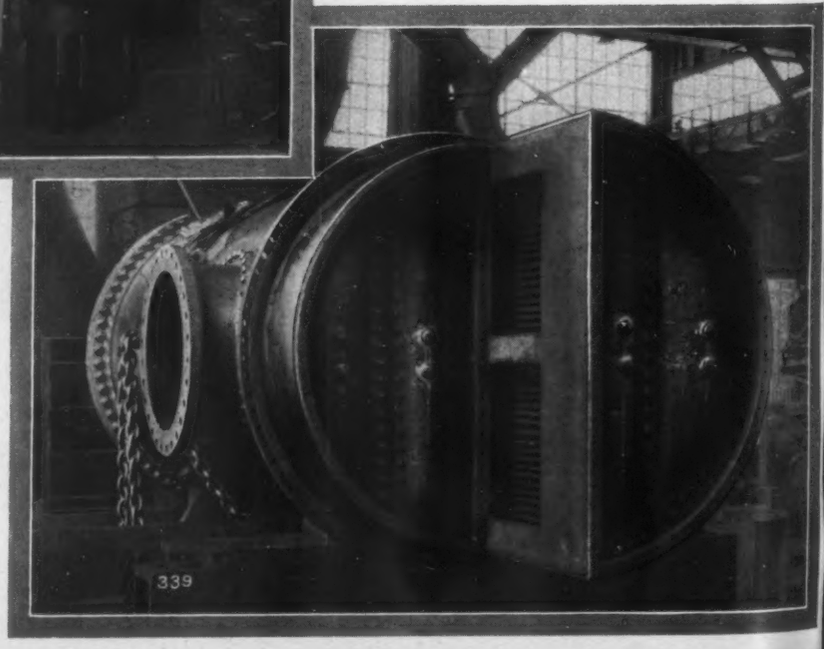
The Condenser illustrated is giving excellent service and is one of the largest Condensers ever built for oil refining.

Weight—32 tons—contains 3600 square feet of surface. Working pressure—200 pound gauge in tubes—30 m.m. absolute in shell. Similar installations have been made in many of the latest vacuum plants both here and abroad. A larger and heavier Leach Condenser is now in the process of manufacture.





Tube bundle of Leach Tower Condenser. Notice the independent floating head for the separate vapor passes.



Leach Tower Condenser with one-half of tube bundle partially removed. The slots at the base are for the admission of the vapors. The free area is equivalent to an 8-foot diameter vapor pipe.

View of the base of same Condenser. The portion below the flange projects into the tower shell. Vapors gain access to the tube bundle through the slotted opening, the hemispherical ends of the shell being provided with covers for the collection of the lubricating oil distillate.

Fracto Control TRADE MARK REG.

LEACH

BACK PRESSURE

THIS condenser sets directly upon the tower with no intervening piping and offers several advantages over the conventional series of condensers connected to the tower by a goose-neck vapor pipe.

HIGHER VACUUM The pressure drop through 60 to 80 feet of vapor piping is eliminated. Also the pressure drop within the condenser is decreased, as the Leach patented construction with independent tube bundles makes it possible to condense all of the Reflux Vapor and part of the product in a single shell. The total pressure drop between the vapor inlet and the vapor outlet of the new design will be one-quarter or less of the pressure drop across a conventional three or four unit vacuum oil condenser. Calculations on a recent installation showed that by the use of the condenser on top of the fractionating tower, the vacuum in the tower could be improved from 60 mm. of mercury to 45 mm. of mercury without change in the vacuum producing equipment. The resultant saving in steam for stripping at the base of the tower is approximately 1500 lbs. per hour.

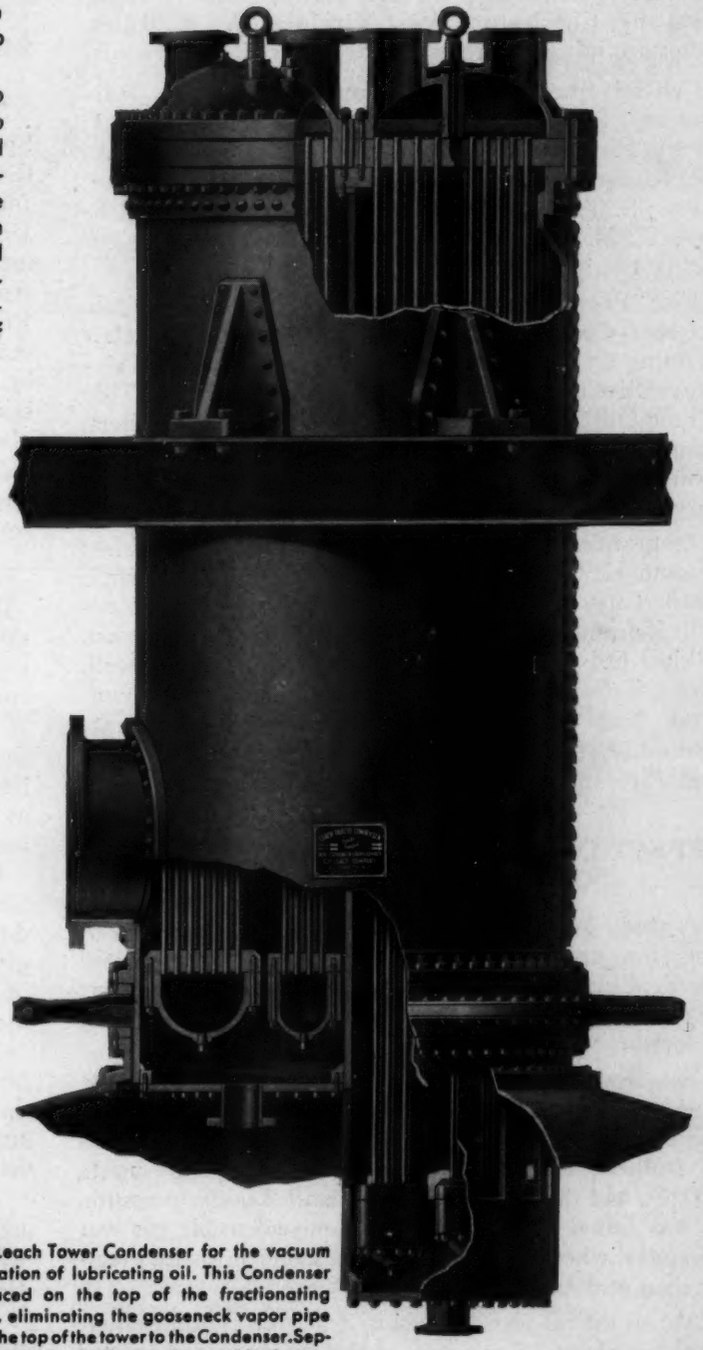
FEWER WELDED JOINTS The size of the vapor pipe from the top of the tower to the condenser is much reduced eliminating about 50% of the total length of welded joints needed in the entire vacuum system.

TOWER FREE TO EXPAND WITH TEMPERATURE CHANGES The smaller vapor pipe also greatly reduces the expansion strains tending to produce leakage. In an 80-foot tower the expansion may be as much as 6 to 8 inches, and it is not hard to show that the stress caused by this distortion is quite severe with a 4 to 6 foot diameter goose-neck vapor pipe.

The new Leach Tower Condenser is a complete condensing unit. Several vapor passes may be employed with a separate tube bundle for each pass. It is possible to employ different cooling media, as oil and water, in the different vapor passes, and the condensate from each pass may be segregated.

If the heat of the vapor is reclaimed by the use of the feed stock for cooling, pre-heat of 400 degrees Fahr. or over may be obtained. Over 78 Leach Fracto Condensers have been furnished for lubricating oil refineries with both the wet process of distillation at about 35 mm. absolute pressure described here, and with the dry process operating at 2 mm. absolute pressure.

The Leach Condenser is fully covered in the U. S. Pat. Office and in the principal foreign countries.



New Leach Tower Condenser for the vacuum distillation of lubricating oil. This Condenser is placed on the top of the fractionating tower, eliminating the gooseneck vapor pipe from the top of the tower to the Condenser. Separate cooling media may be used in the two halves of this Condenser, and the distillates from each half may be removed separately.

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225 BROADWAY NEW YORK
Main Office: Elizabeth, N. J.

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EFFECT OF PRESSURE IN PRODUCING GASOLINE FROM SHALE OIL

A study of the effect of pressure in producing gasoline from crude shale oil is being made by the United States Bureau of Mines, Department of Commerce, laboratories at the University of Colorado, Boulder, Colorado.

A series of cracking experiments at pressures ranging from atmospheric to 150 pounds pressure was made on the crude shale oil produced in the government retorts at Rulison, Colorado. The crude was topped up to 400°F., and this stock was then distilled under pressure. It was found that considerable noncondensible gas was produced when the oil was treated under pressure greater than atmospheric.

When the oil was distilled to dry coke at atmospheric pressure about 7.5 per cent. of the charge was converted into gas. The analysis of this gas was as follows: carbon dioxide, 0.5 per cent.; illuminants, 27.5 per cent.; oxygen, 2.7 per cent.; hydrogen, 24.5 per cent.; carbon monoxide, 1.6 per cent.; methane, 24.3 per cent.; ethane, 10.1 per cent., and nitrogen, 8.8. per cent. Its specific gravity was .656 and the B.t.u. was 1000. The topped oil cracked under pressures up to 150 pounds yielded from 16 per cent. to 20 per cent. by weight of dry gas free from hydrogen sulphide. The analysis of this gas was as follows: carbon dioxide, 0.6 per cent.; illuminants, 5.4 per cent.; oxygen, 3.3 per cent.; hydrogen, 3.0 per cent.; carbon monoxide, 6.6 per cent.; methane, 59.0 per cent.; ethane, 9.1 per cent, and nitrogen, 11.0 per cent. Its specific gravity was approximately .695 and the B.t.u. was 1000.

These analyses are not average but typical, and show the predominating gases in their relative proportions. The amount of methane sometimes runs as high as 65.0 per cent.

REVISED MOTOR GASOLINE SPECIFICATIONS NOW AVAILABLE

The revision of the United States Government Master Specification for Motor Gasoline, which becomes effective September 11, 1929, has been made available in the form of an insert to Technical Paper 323B of the United States Bureau of Mines, Department of Commerce. Copies of Technical Paper 323B are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 15 cents. The revisions cover the grade of gasoline used by the United States government as a fuel for automobiles, truck tractor, motor boat and similar engines and also a special grade of fuel which may be used for ambulances, fire engines, emergency vehicles, military and naval equipment, and for other equipment under special conditions.

Possibilities of fitting oil cracking operations into the manufacture of illuminating gas, as well as motor fuel, appear to be developing not only in this country, but abroad.

This is indicated during recent visits of two distinguished foreign technologists to the offices and laboratories of the Universal Oil Products Company at Chicago, according to Paul Truesdell of that company.

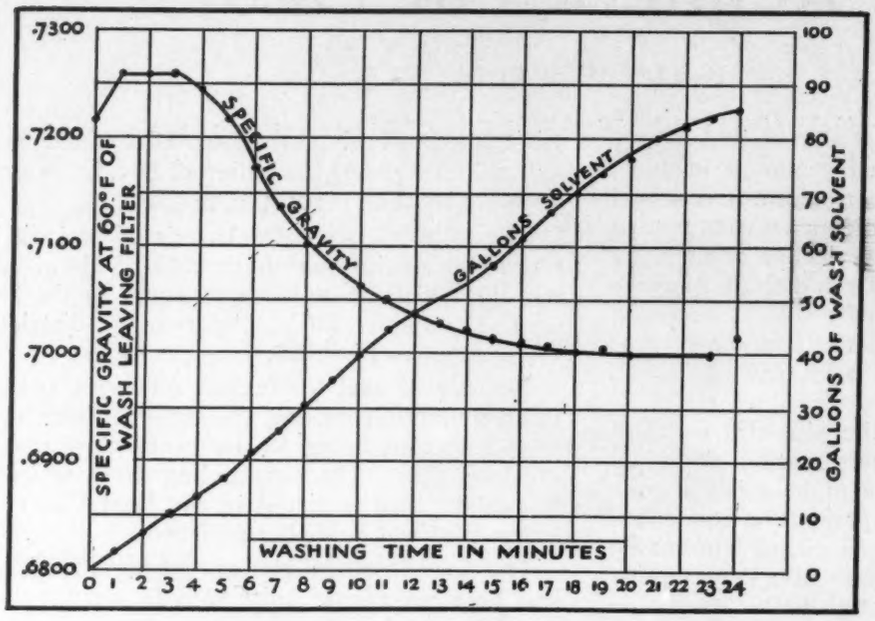
One of these visitors is E. F. Armstrong, a director of the South Metropolitan Gas Company in London, and the other is Walter Muller, head of the Engineering Economics department of the University of Chile at Santiago, and also chief engineer of the leading gas company of Chile.

These men are studying the possibilities of using cracking equipment to make high grade motor fuel on one hand and at the same time enrich manufactured gas through the utilization of the fixed gases from the cracking stills.

At the request of E. A. Dieterle, chairman of the gas section of the Western Society of Engineers, Chicago, Doctors J. C. Morrell and Gustav Egloff of the Universal Oil Products Company are preparing a paper on the possibilities of combining cracking operations with gas manufacture.

Burrell-Mase Engineering Company, Pittsburgh, is rebuilding the absorption natural gasoline plant of the Equitable Gas Company, Pittsburgh. The gasoline plant operated by the Salem Gasoline Company at Salem, West Virginia, is also being remodeled and reconstructed by the same firm. At the Petrolia, Pennsylvania, refinery of W. H. Daugherty & Sons Refining Company, Burrell-Mase Engineering Company is erecting a new absorption type gasoline vapor recovery plant, which will be placed in operation at an early date.

Contact Filtration



Note:

1. Uniformity of line.
2. Evenness of cake.
3. Smoothness of washing.
4. Washes completely clean with minimum of time and solvent.

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THE Vallez works in a closed system, never being open during operation, thereby avoiding solvent losses and dust, and minimizing fire hazard.

The Vallez operation of filtering is immediately followed by a washing with solvents. This washing is thorough because of the uniform thickness of cake, due to rotating leaf, and requires a minimum of solvent.

The solvent can be entirely steamed from the cake in the filter, if desired.

The capacity is large because of high filtration rate and minimum time for blowing and dumping.

You know how dusty the dumping of a washed Fuller's Earth or any other absorbent has been. In Vallez filter operation there is no dust.

The Vallez is not opened to discharge and the hopper underneath is covered.

Many Vallez filters are used successfully in dewaxing operations, with the aid of volatile diluent.

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Survey of Fuel Consumption At Refineries in 1928[1]

By G. R. HOPKINS[2]

THE petroleum refiners of the United States made rapid strides in fuel economy in 1928, when the calculated number of B. t. u. required to refine a barrel of crude petroleum was 637,000 as compared with 698,000 in 1927, a decline of nine per cent. The major portion of this indicated increase in fuel efficiency was undoubtedly due to the gain in the use of the pipe-still and the continuous process of refining as contrasted with the old batch method of distillation.

The more extensive use of the pipe-still was not the only way in which the refiners lowered their fuel requirements in 1928. The use of heat-exchangers, in which the heat from hot vapors to be condensed is used to heat the incoming cold oil, also increased in 1928, and in addition the refiners have kept abreast of the times in saving fuel through better insulation and improved burners.

For 1928 the refiners burned as fuel the following: 46,400,000 barrels of fuel oil; 3,362,000 short tons of coal; 114,950,000,000 cubic feet of natural gas; 77,313,000,000 cubic feet of refinery or still gases; and 470,000 short tons of coke, in addition to a little electricity. This fuel was calculated to have produced a grand total of 582,156 billion of B. t. u., as compared with 578,784 billions B. t. u. in 1927.

The total of 46,400,000 barrels of fuel oil burned represents an increase over 1927 of about 5,000,000 barrels, which made it about equal to the 1926 figure. Practically all of the refinery districts used more oil as fuel in 1928.

The use of coal for fuel at refineries again registered a material decline, the total for 1928 of 3,362,000 short tons being 33 per cent below that of the previous year. The outstanding decrease in the use of coal in 1928 occurred in the East Coast district, where coal was probably replaced by oil.

The use of natural gas as fuel at refineries, which had been increasing quite rapidly, declined in 1928. The total used in that year amounted to 114,950,000,000 cubic feet as against 123,395,000,000 cubic feet in 1927. The largest factor in this decline was the displacement of about 7,500,000,000 cubic feet in Oklahoma by slightly over 1,000,000 barrels of fuel oil. On the other hand, the use of refinery gas showed a very material increase, there being 77,313,000,000 cubic feet of this material burned in 1928 as com-

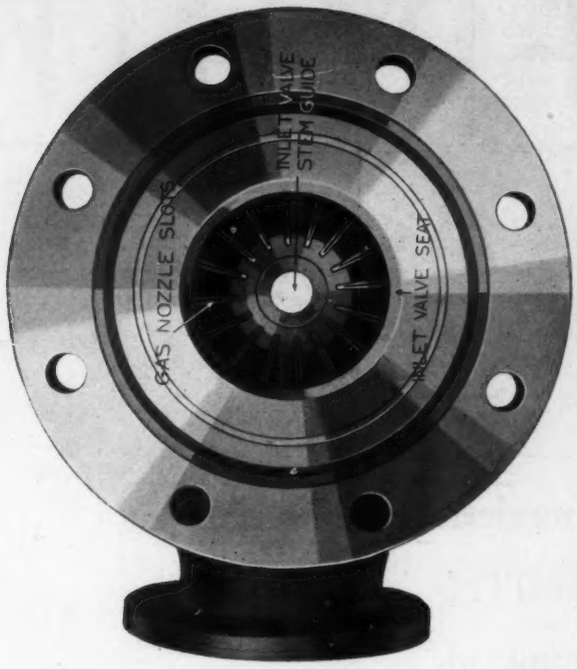
[1] "Reprinted from U. S. Bureau of Mines Reports of Investigations 2964."

[2] Associate economic analyst, U. S. Bureau of Mines.

FUEL USED AT REFINERIES IN THE UNITED STATES, 1927-1928

	Oil[1] (thousands of bbls.)	Coal (thousands of short tons)	Gas (millions of cubic feet)		Coke (thousands of short tons)	Other	Total B. t. u. (billions approx.)	Crude runs to stills (thousands of bbls.)	B. t. u. per barrel crude run
			Natural	Refinery					
1927									
East Coast	12,845	1,545	....	8,062	81	...	128,135	150,559	851,000
Appalachian	703	1,277	2,547	1,482	5	([2])	41,802	28,941	1,444,000
Ind., Ill., Ky., etc.	4,773	2,036	....	5,390	44	([3])	88,555	75,807	1,168,000
Oklahoma	2,040	6	23,630	8,018	14	...	46,047	65,699	701,000
Kansas and Missouri	2,328	121	7,398	2,074	7	...	27,270	36,172	754,000
Texas Inland	1,221	....	4,666	1,328	8	...	13,859	37,092	374,000
Texas Gulf Coast	9,031	....	27,338	16,042	163	...	104,625	130,003	805,000
Total Texas	10,252	....	32,004	17,370	171	...	118,484	167,095	709,000
Ark.-La. Inland	57	....	9,102	872	...	...	10,815	20,031	540,000
La. Gulf Coast	2,248	....	16,143	4,300	118	...	38,493	50,413	764,000
Total La.-Ark.	2,305	....	25,245	5,172	118	...	49,308	70,444	700,000
Rocky Mountain	1,001	46	14,740	3,738	10	...	26,904	25,026	1,075,000
California	5,215	....	17,831	2,159	...	...	52,279	209,092	250,000
Total U. S.	41,462	5,031	123,395	53,465	450	...	.....	828,835	698,000
Total B. t. u. (billions approx.)	248,772	130,805	129,565	56,138	13,500	3	378,784	.....	.....
1928									
East Coast	14,911	844	....	11,402	74	([4])	125,966	170,506	739,000
Appalachian	952	1,077	2,692	2,243	18	([5])	39,437	33,643	1,172,000
Ind., Ill., Ky., etc	6,054	1,373	....	12,149	82	([6])	87,240	98,905	882,000
Oklahoma	3,162	1	16,184	7,311	3	...	43,758	70,748	619,000
Kansas and Missouri	2,149	49	7,171	5,177	9	...	27,404	40,594	675,000
Texas Inland	1,705	....	4,044	1,772	7	...	16,547	48,096	344,000
Texas Gulf Coast	9,081	....	25,597	21,242	158	...	108,407	137,980	786,000
Total Texas	10,786	....	29,641	23,014	165	...	124,954	186,076	672,000
Ark.-La. Inland	87	....	8,351	2,408	...	...	11,819	22,675	521,000
La. Gulf Coast	1,958	....	17,420	4,500	104	...	37,884	52,685	717,000
Total La.-Ark.	2,045	....	25,771	6,908	104	...	49,703	75,540	658,000
Rocky Mountain	987	18	16,088	4,212	13	...	28,095	26,061	1,078,000
California	5,354	....	17,403	4,897	2	...	55,599	211,222	263,000
Total U. S.	46,400	3,362	114,950	77,313	470	...	.....	913,295	637,000
Total B. t. u. (billions approx.)	278,400	87,412	120,698	81,179	14,100	367	582,156	.....	.....

[1] Includes acid sludge. [2] 437.783 kilowatts. [3] 482,700 kilowatts. [4] 12,133 tons refuse. [5] 231,416 kilowatts. [6] 502,360 kilowatts.



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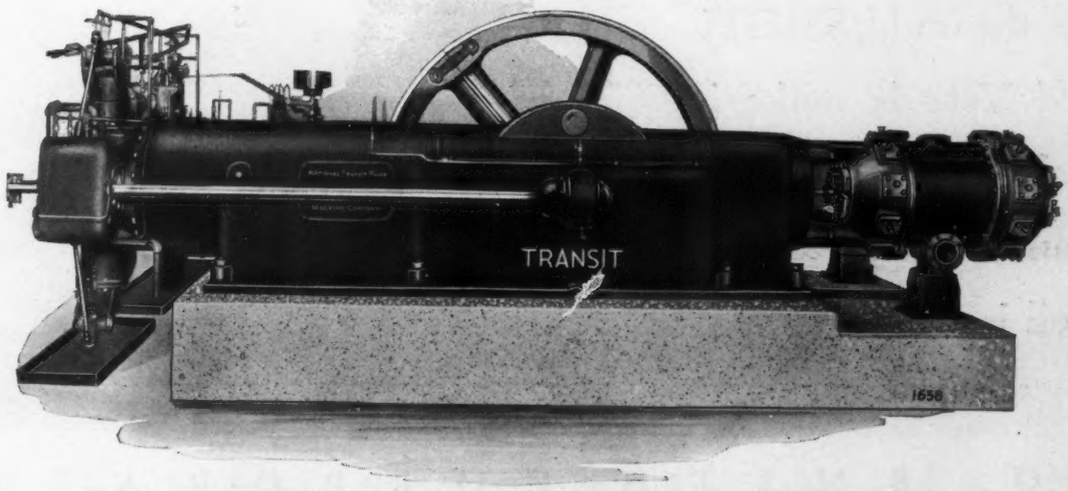

Fig. 1658—TRANSIT 17 x 24", Model 26 Gas Engine, with compressors. Side View.

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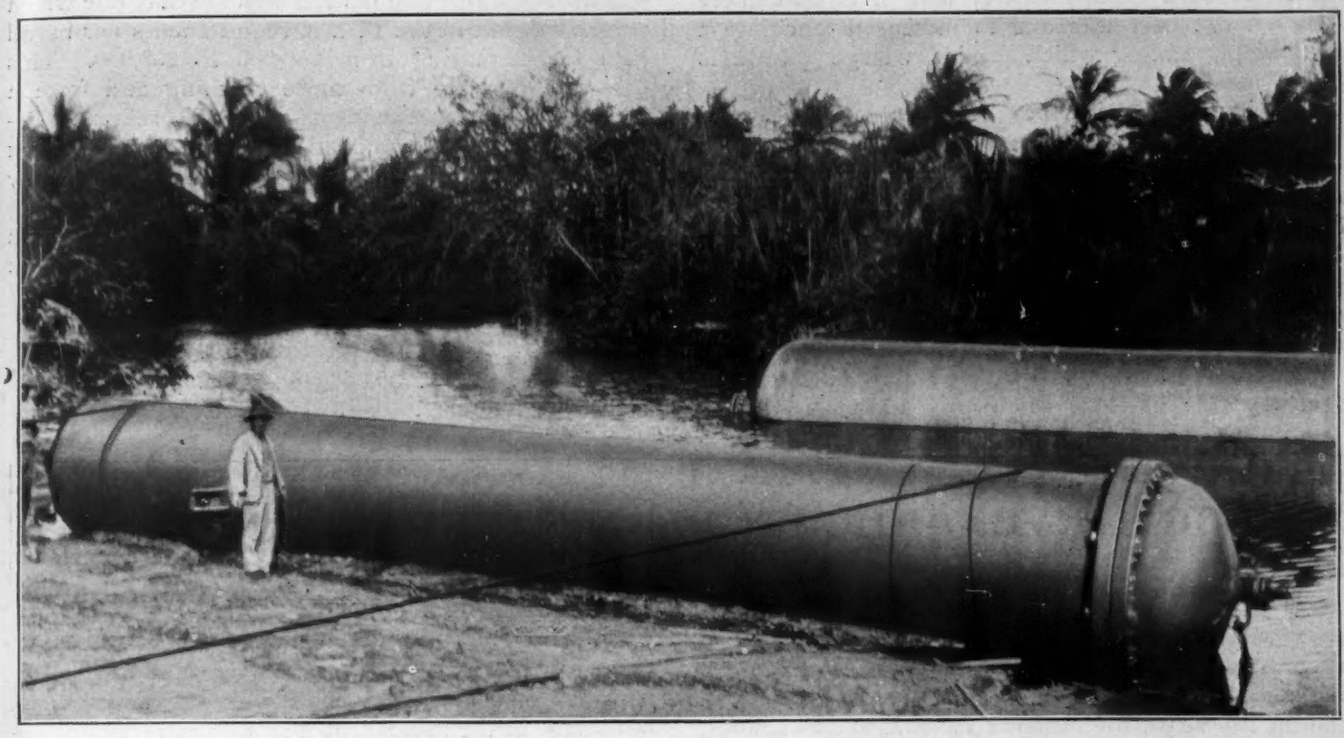

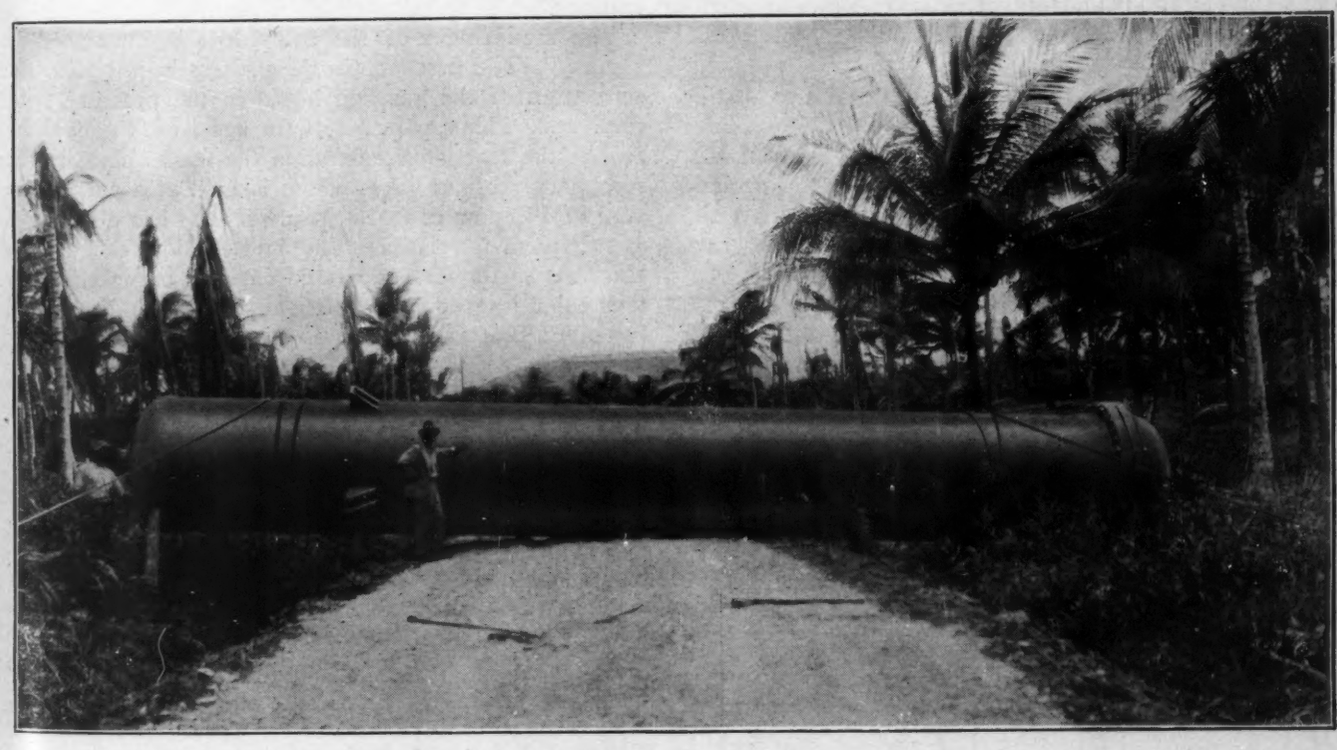

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CRACKING STILLS

pared with 53,465,000,000 cubic feet in 1927, a gain of 45 per cent. Although it is probable that a portion of this increase in the total refinery gas utilized as fuel was due to the installation of equipment designed to save gases formerly lost, it is also likely that a large part was due to increased cracking, a method of refining which produces large quantities of still gases.

The increasing tendency of recent years toward the utilization of petroleum coke as refinery fuel was somewhat checked in 1928 by the low price of fuel oil. However, the total amount of petroleum coke burned increased from 450,000 short tons in 1927 to 470,000 short tons in 1928. A total of 733,766 kilowatts of electricity was used as refinery fuel in 1928 by three refineries, as compared with 920,483 kilowatts used by four refineries in 1927.

The Appalachian district made a notable gain in fuel economy in 1928, when only 1,172,000 B. t. u. were required per barrel of crude refined as compared with 1,444,000 B. t. u. in 1927. This saving was due in a large measure to the economies effected through the installation of pipe-stills and other equipment. The California district was the only one which showed a gain in the B. t. u. requirements per barrel in 1928, increasing from 250,000 to 263,000. This probably resulted from more cracking and from a more complete processing of the crude refined. Despite this increase, California easily retained its rank as the leading district from the standpoint of low fuel requirements.

The following B. t. u. contents for the various fuels were used in the foregoing calculations of B. t. u.:

Oil	6,000,000 B. t. u. per barrel
Coal	26,000,000 B. t. u. per short ton
Gas	1,050 B. t. u. per cubic foot
Coke	30,000,000 B. t. u. per short ton
1 kilowatt-hour . .	3,415 B. t. u.

Some Developments in Commercial Cracking

(*Continued from page 66*)

gases could be eliminated with a relatively small loss of gasoline, if separation could be effected at pressures in excess of about 150 pounds per square inch. Separation in two steps, for instance, the first at 250 pounds, the second at 150 pounds, involves lower losses of gasoline than separation in a single step at the lower pressure.

The naphtha withdrawn at the lower pressure is still a very "wild" product. If released to atmospheric pressure, a considerable amount of rich gas is given off, which must be treated in a compression or absorption plant for the recovery of the gasoline fractions. With gases high in hydrogen sulfide, it is practically necessary to subject them first to a preliminary treatment for removal of this constituent. Both the naphtha and recovered gasoline still contain appreciable amounts of undesirable fractions and should, therefore, be subjected to a final rectifying step to complete the process.

A more economical solution to the problem was finally developed, involving high pressure rectification of the naphtha before the final release of pressure. A very sharp fractionation is thereby obtained between desirable and undesirable constituents. The gas is practically free of gasoline fractions; the naphtha can be processed to any desirable vapor pressure, and is substantially free of hydrogen sulfide and other fixed gases—an important advantage in the subsequent treating and rerunning operations.

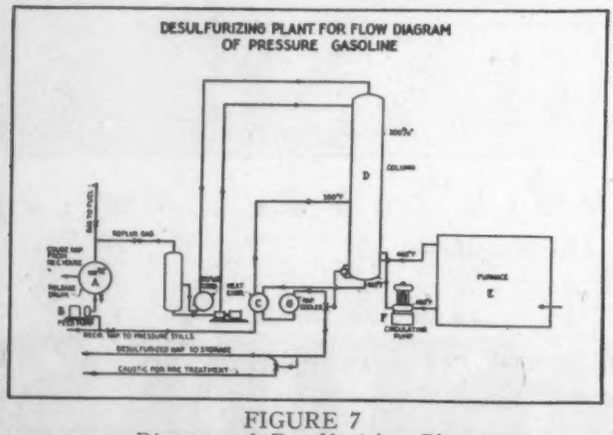
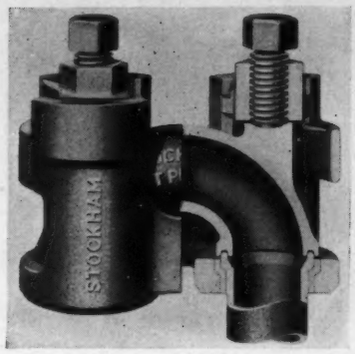


FIGURE 7
Diagram of Desulfurizing Plant

The arangement of the equipment is illustrated in Figure 7. The first step in the process begins with the separation of the gas and liquid in the pressure stills receivers. This separation of the gas from the naphtha aids in the fractional separation that takes place in the secondary receiver (A), which is held at a gage pressure of 140 pounds to 160 pounds. The gas discharged at this point is relatively dry, and the loss of gasoline fractions small. The separated naphtha is picked up at this point by a pump shown at (B), and discharged through a heat exchanger (C) into a bubble-plate tower (D) under a pressure of about 300 pounds. The stock in the bottom of the tower is maintained at about 460 degrees F. by circulation through a furnace (E) by means of a pump. The rectified naphtha passes from the bottom of the tower through the heat exchanger and a cooler (G). Reflux is produced by water cooling, and is pumped to the top of the tower which is held at about 110 degrees F. The exact temperatures will, of course, depend upon the vapor pressure of the naphtha and the degree of stripping desired.

The receiver (A) is of quite large capacity, and so acts as a surge chamber in which minor fluctuations in the rate of naphtha production are absorbed. The discharge of a relatively large volume of gas at this point relieves the demand on the tower, and makes it possible to operate at moderate pressures while using an ordinary water supply for reflux condensing. The principles involved in this process will be readily understood. This process is practical, and has been entirely successful in operation. The rectified naphtha is practically free from hydrogen sulfide which is discharged with the gases, and the caustic required for pre-treatment has been reduced to a minimum.



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400	pounds	per	square	inch at	900° F.
800	"	"	"	"	900° F.
1200	"	"	"	"	900° F.
3000	"	"	"	"	1000° F.
5000	"	"	"	"	1000° F.
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Stockham Fantz-Type Return Bends are available in sizes from one inch to five inch, inclusive.

Tube mills are prepared to furnish carbon steel or alloy steel Tubes to Stockham specifications on short notice.

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IN the 96 years that Cooper engines and power machinery have been built at Mt. Vernon, the name "Cooper" has meant but one thing to Cooper customers and prospects—*Finest equipment of its type.*

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Therefore, when the Cooper and Bessemer interests united for greater service to this Industry, they decided to retain the names "Cooper engines" and "Bessemer engines" until the time when the name COOPER-BESSEMER could command even more respect than Cooper or Bessemer alone.

That time is here. The two engine lines are combined and standardized into one. Every single engine has been improved, refined or redesigned. Cooper and Bessemer men, working together, have accomplished these results through joint research, experiments and tests. And the products of their united efforts have now thoroughly earned this greater name COOPER-BESSEMER.

While the individual engine names—COOPER, BESSEMER, HOPE—are now replaced, the former type numbers remain unchanged. A new, handy-reference, combined line folder has been prepared. It shows the type designation, range of sizes, construction and chief applications of every Cooper-Bessemer product.

THE COOPER-BESSEMER CORPORATION

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Branch offices in all principal oil and gas fields

Institute Realignment Gives Refining More Prominence At Sessions

(*Continued from page* 56)

Motor Company to determine the pecularities liable to arise in using the methods in the various laboratories. When this is completed, representatives of the Bureau will go to each laboratory and see that all factors are standardized and a uniform method used and the engine adjusted as nearly as possible to a standard. The runs will then be made by the various laboratories and the results sent to the Bureau for compiling and analysis.

The committee has met with cooperation on every side, and has had gestures from technical bodies of foreign countries anxious to contribute to this work. While it is hoped by some that this engine is close to the final form, the committee desires that it be considered at this stage as being developed for the tests about to be undertaken; and that a final engine will probably be built suitable for the standard test procedure, which it is hoped, will be the outcome of the above tests.

"Gas Locking Tendencies of Aviation Gasolines in Airplane Fuel Lines and Feed Supply", as presented by C. C. Moore, Jr., and M. S. Reynolds, Union Oil Company of California, reports that the occurrence of vapor lock in aviation work is of great importance, not only as a limiting factor in performance, but from the standpoint of safety. An experimental investigation was made to determine the effect of gasoline volatility on the tendency of aviation gasoline to gas-lock in airplane fuel lines and feed pumps, thus providing a basis for predicting the performance of aviation gasoline from a knowledge of their volatility.

The desired data were obtained by ascertaining the pumping rates of several gasolines covering a wide range of volatility. An electrically operated gasoline pump and a system of fuel lines and reservoirs in which the atmospheric pressure and gasoline temperature could be varied independently provided conditions corresponding to those encountered in aviation practice.

The data show that: (1) in general, there is a definite relationship between the vapor locking tendencies of normal aviation gasoline and their 10 per cent points in the A.S.T.M. distillation test; (2) the average boiling point of a gasoline is only roughly indicative of its tendency to vapor-lock and, (3) the initial boiling point is a less satisfactory indication of the tendency to vapor-lock than the 10 per cent point.

Graphic charts were developed by the use of which the relative performance of aviation gasolines at various altitudes and temperatures can be predicted from a consideration of the 10 per cent point in the A.S.T. M. distillation.

CRACKING SYMPOSIUM

A. L. Strout, Standard Oil Company of California, in his paper "Some Developments in Commercial Cracking" states that as a result of intensive study and experimental work during the past few years we have succeeded in determining principles which influence the formation of coke in the cracking process and the character of the cracked fuel oil as regards sediment. Having determined how to apply these principles through the design of equipment and method of operation, the benefits resulting therefrom have been realized to a gratifying degree with commercial units. A plant which embodies the principles discussed by Mr. Strout includes a furnace of ample heating surface, in which the radiant heat is well distributed over a large number of tubes and in which high velocities are maintained. The evaporator is of small cross-section, with provision for maintaining the liquid at a low level. This liquid has a commercial tar content of 35 per cent to 40 per cent, and it is withdrawn to a flash still at low pressure where it is distilled by its residual heat. The commercial tar is withdrawn from this still and the vapors are condensed in a heat exchanger. The condensate from this chamber passes to a mixing chamber, to which fresh feed is admitted. The mixed stocks from this chamber are pumped through the exchanger to this system. The vapors from the evaporator pass to a fractionating tower, from which naphtha is drawn overhead and cycle stock from the bottom. The cycle stock and fresh feed are pumped to the furnace.

A plant of this design will operate successfully on heavy gas oil or topped crude, with practically no formation of coke, and will produce a tar with a sediment approximately 0.3 to 0.5 per cent. The yield from a plant of this kind will be contingent upon the degree to which tar is reduced by distillation. The quality of tar withdrawn will be dictated, as a rule, by the viscosity required for blending and marketing purposes.

Results in vapor phase cracking research are reported in detail in "Principles of Vapor Phase Cracking" as presented by R. C. Osterstrom and C. R. Wagner, Pure Oil Company. Edivence is adduced to show that gas and fuel are the results of secondary reactions entirely. It is shown that when the time of reaction exceeds one second at temperature above 1,000 degrees F., secondary reaction products almost exclusively are found in the distillate produced. Pressure up to two atmospheres has little or no effect except in altering the time of reaction. Gas production is shown as a function of time and temperature. It is believed that quality of product is affected more

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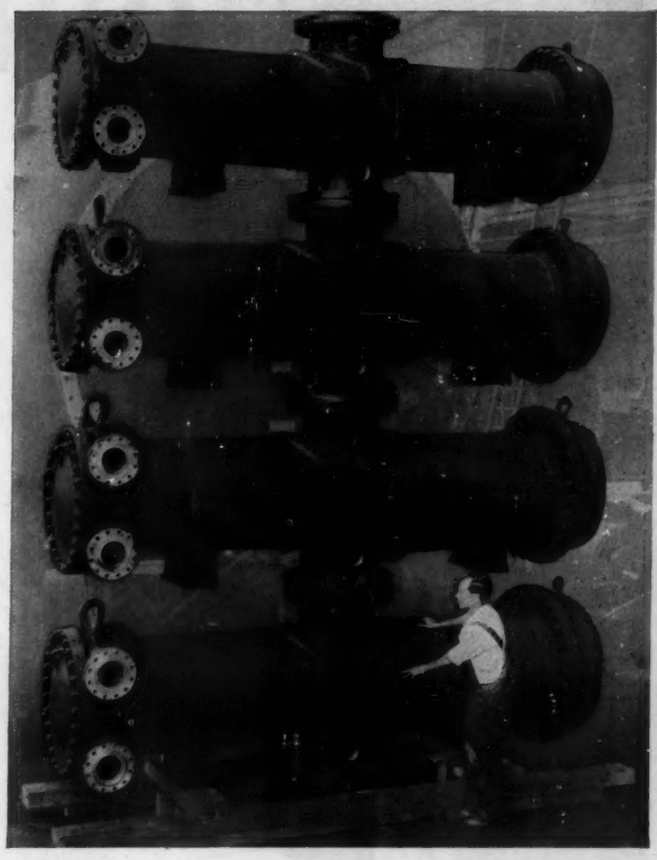

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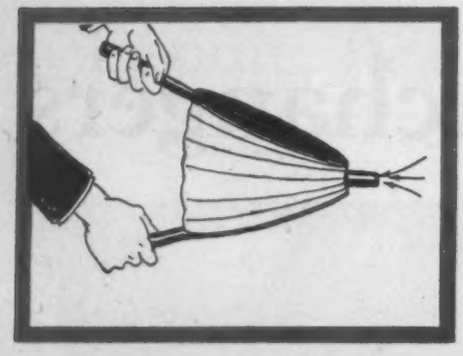

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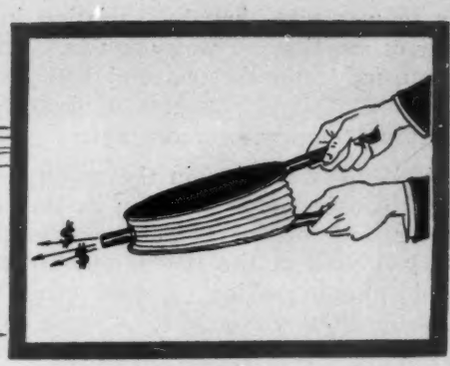

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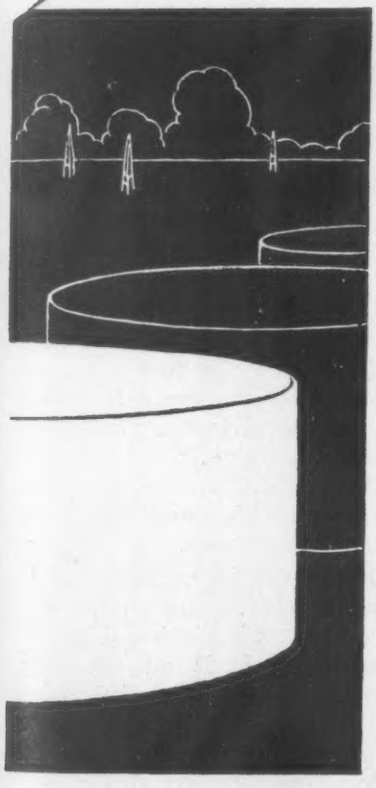

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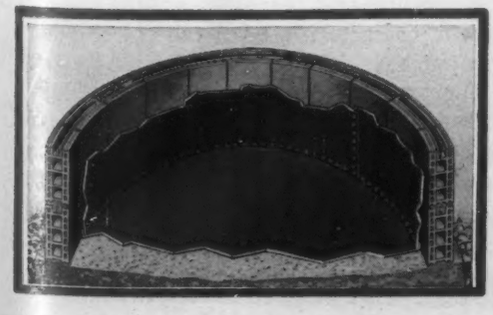
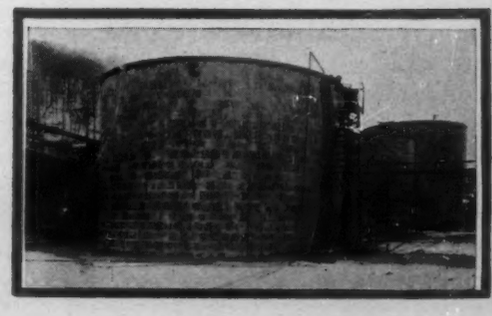


Cross-section showing two courses Segmen-Tile. Note curvature in wall. Ends are cut to any radius depending on diameter of tank.



The Pump House Station of the Kendall Refining Co. Tanks are completely walled in by Segmen-Tile, to insulate and protect them.

by temperature than by variation in time or pressure of reaction. The vapor phase cracking reaction is strongly endothermic and therefore requires the addition of large amounts of heat to maintain the cracking temperature constant.

Although variation in the quality of the cracking stock causes some variation in the quality of the motor fuel products, this tendency is much less marked than at the low temperatures employed in liquid phase cracking. On the other hand, it is conceivable that the quantities of a given quality of product produced might vary a great deal more with variations in physical and chemical properties of charging stocks than in the case of liquid phase cracking—assuming that optimum operating conditions in the two methods of cracking are obtained before comparisons are drawn. Even though the quantities and qualities may not be materially affected, yet it is entirely conceivable that the extent of treating necessary to produce a finished, stable product, may be influenced by the chemical properties of the original charging stock. Research work along this line is now in progress, and will probably be made the subject matter of a subsequent paper.

The discussion of a cracking process incorporating new features of design under the title "A New Type of Cracking Unit" was presented by Luis De Florez, consulting engineer, who said in part: "The problems involved in the design of a cracking unit capable of a wide range of operation are not merely of a structural nature: provision must be to permit a more or less independent control of the operating factors, such as temperature, pressure and time, in order to bring about the required conditions to produce the type of results desired. These problems present many difficulties, none of which, however, precludes a practical solution if attacked with the clear understanding that cracking at various parts of the scale differs more in detail than in theory of processing.

"A solution to these problems has been found in the evolution of a design combining certain structural features and an operating cycle which can be balanced with widely differing rates of cracking per pass.—The unit (latest type) comprised a vertical tube heating element, a primary tower providing an expansion chamber and recycle stock fractionating column, a secondary tower providing a sycle stock accumulator and a gasoline fractionating column, a condenser, a gas separator, and an absorption tower for the recovery of gasoline from the gas, together with such supplementary equipment, in the form of heat exchangers and reflux condensers, as may be necessary for efficient operation."

The process is described in detail with operating results cited where processing on various crudes and gas oils. The paper as presented is published elsewhere in this issue. Results obtained justify the belief that cracking low grade charging stocks at temperatures of the order of 1,050 degrees F. is practical and economical even when process gas is valued as fuel. It is indicated that it is feasible to build a cracking unit, at moderate cost, which will operate effectually on widely differing charging stocks and under widely varying operating conditions.

CORROSION SYMPOSIUM

The report of committee on refiner and marine corrosion was presented by Walter Samans, The Atlantic Refining Company. In summing up the report stated that the economic comparison of measures to counteract corrosion was mentioned and while it seems scarcely necessary to explain in detail how such comparisons are made; but for fear that some may misinterpret either the purpose of the tests being conducted or the tentative deductions made, or to mis-apply the information that may be issued, it is thought desirable to report the fundamental considerations. In the use of special materials in still construction, the reduction in shutdown time by reason of lessened repairs and of longer time between renewals is expressed in value of still-hours when in operation, and based on lost profits if the still capacity is required to supply required produces.

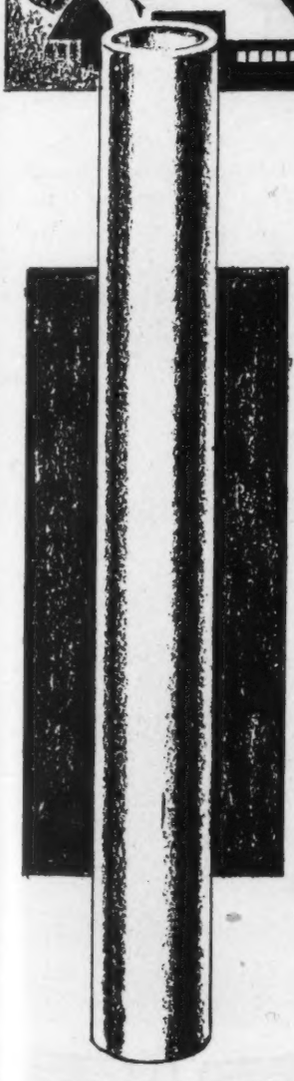
In the use of special materials in tubular equipment, the reduced time in cleaning and the better quality of products by reason of elimination of contamination due to minor leaks, that may not easily be corrected except in the complete renewals of tube nets, must be considered. This naturally points out the advantages of heavier initial gauges in tubes, as their corrosion can not be entirely eliminated. The work need on repair and replacements should also come within the normal shutdown time of the mapor equipment of which the tubular equipment is a part.

In the application to tanks of paints or other protective coatings, the life and cost of new roofs of various initial thickness or of various iron alloys, and their replacement costs, compared to the possibility and cost of taking tanks out of service; the praparation of the surface and the cost of the coating and its application, and the frequency with which this must be done, must all be taken into account.

In the use of special material in minor refinery equipment, including valves and control equipment, the importance of this equipment in cintinued operation of the apparatus of which, it is an auxiliary must be considered, bearing in mind the difficulties of inspection and cost of repairs. In the above studies, we should not forget the fire hazard involved by failures in various locations, and secondary failures during a fire that may increase the extent of fire losses. Safety to the operators is of paramount importance.

Walter G. Whitman and J. K. Roberts, Standard Oil Company (Indiana), in their paper "Pressure Still Corrosion," conclude that the most promising protective measures for pressure still corrosion are the use of lime, lines of cement, refractories, or metal, and the use of resistant alloys such as 18 per cent. chrome—eight per cent. nickel for parts of equipment having unduly short life. The 4- 6- per cent chrome alloy, because of its relatively low cost and good resistant qualities, gives promise of wide usefulness for all types of equipment.

Adequate protective measures for pressure still equipment are still in an early stage of development, and must advance rapidly to keep pace with the present ten-



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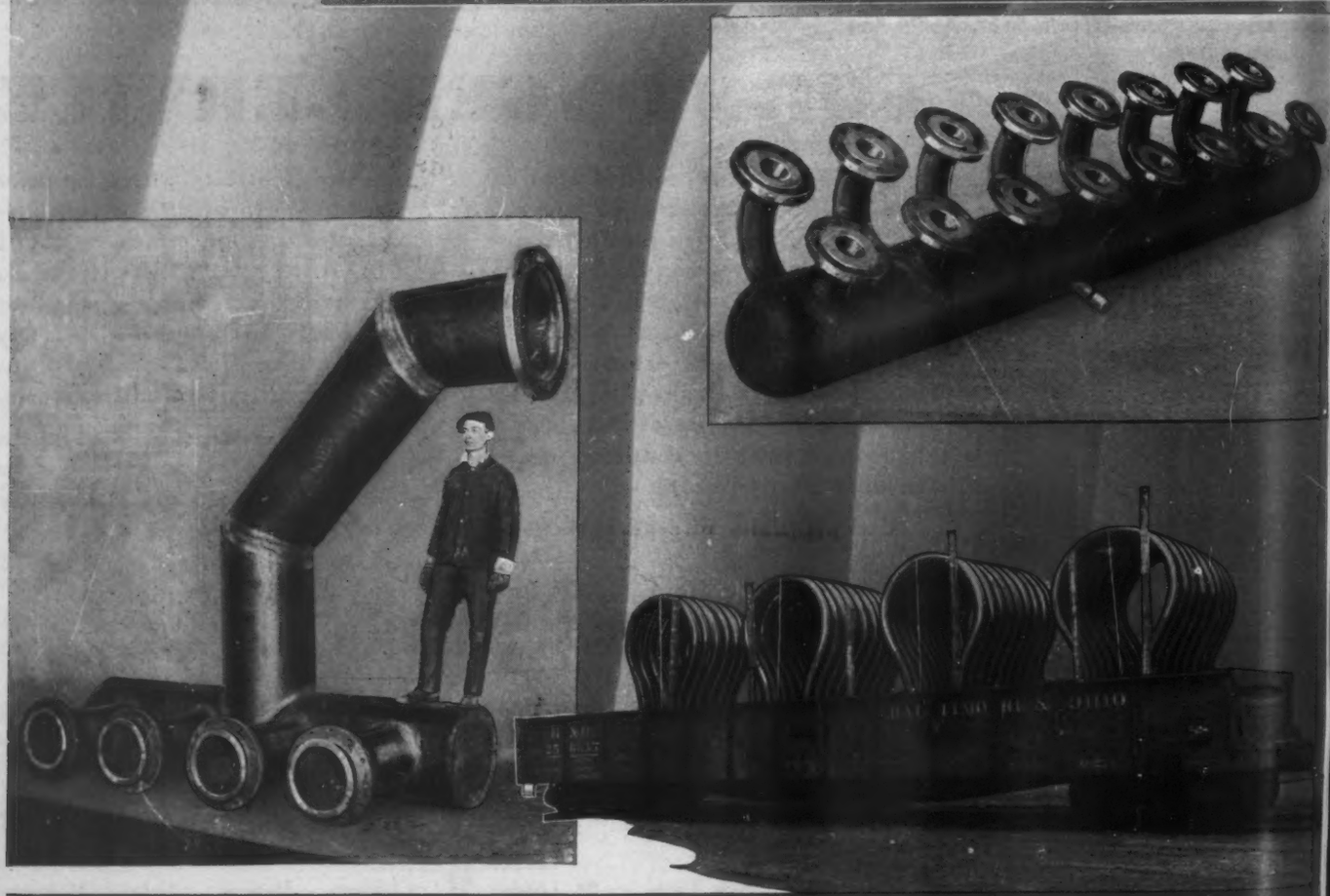

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dencies towards increased operating temperatures and the influx of sour crudes. Progress along this line can be best effected by co-operative efforts such as are being fostered by the general committee on corrosion of the American Petroleum Institute. The Institute's corrosion commitee has been studying various methods of making frequent tests and inspections for corrosion, and expects to adopt and publish a standard method of testing and reporting results in the near future.

"Practical Methods of Combating Corrosion in Oil Refinery Equipment," by R. L. Duff, Standard Oil Development Company, was a general resume and reference to many items that have to be studied, and conveys the thought that corrosion is of tremendous importance in economical refinery operation and a subject involving considerable research, test work, and study. The corrosion of metals in an oil refinery is commanding considerable attention throughout the industry. The trend toward higher pressures and temperatures in refinery processes is demanding the use of materials possessing higher physical properties, as well as corrosion resistance. In the search for the proper materials for use in a particular location, many factors must be considered, such as temperature, pressure, velocity, strength required, expansion, ductility, conductivity, cost of material, obsolescence of equipment, ease of fabrication, resistance to shock or impact, as well as corrosion resistance. Alloys are being utilized to meet these complex problems, and their use is becoming more widespread. The importance of tests is, therefore, emphasized in fact of the highly specialized materials being produced. Coatings are also of importance, and are being used successfully in many cases. Ever changing conditions and methods call for continual research. There is no single application of material or method that can be universally adopted.

"Cause of Corrosion in Cracking Plants," by E. Retailliau and F. R. Lang, Shell Petroleum Corporation, reports results of a series of tests in which the main fact evidenced by such experiments is the dissociation of hydrogen sulphide and organic sulphur compounds in a closed tube. It is indicated that, in plant operation, such compounds are partly decomposed, yielding some free sulphur whose corrosive action surpasses by far all other corrosive action possibly present in the charging stock. In cracking plants using a sulphur-bearing charging stock corrosion is mainly due to the action of elementary sulphur during the period of cracking, with additional corrosion by hydrogen sulphide and sulphur dioxide taking place during the steaming period. The mechanism of corrosion seems to be the decomposition of organic sulphur compounds, liberating hydrogen sulphide, which in turn is decomposed at the temperatures employed, into hydrogen and elementary sulphur. The elementary sulphur then attacks the steel.

GENERAL REFINERY THEOLOGY

"Some Properties of Mid-Continent Crude" was the title of a paper presented by Ogden Fitzsimmons and W. H. Bahlke, Standard Oil Company of Indiana, Whiting, Indiana, including a correlation between molecular weights and several properties of Mid-Continent crude and its fractions. Results are graphically presented by means of a series of charts, indicative of relationship between A. P. I. gravity and molecular weight, the A. S. T. M. 50 per cent. point and molecular weight, the reciprocal molecular weight and weight per cent. for narrow cuts, total volume per cent. distillate and molecular weight, and the like. In many of the calculations necessary for the design of refinery equipment, the molecular weight of the substance under consideration is involved. The usual data available for the solution of a problem consists largely of data on such properties as A. S. T. M. distillations, gravity and viscosity. Correlation of these more easily determined physical properties and molecular weight would permit placing many of the calculations on a more certain basis.

"Studies in Distillation" (contribution from the department of chemical engineering, Massachusetts Institute of Technology) and "Rectification of Heavy Naphtha" (abstract from thesis in partial fulfillment of the requirements for the doctor's degree, Massachusetts Institute of Technology), presented by W. K. Lewis and E. R. Smoley, department of chemical engineering, Massachusetts Institute of Technology, confirmed the method of Wilde as offering the best scientific basis at present available for the design of rectification equipment for the petroleum industry. The first attempt to solve by the application of the fundamental principles developed by Sorel and Hausbrand, the problems involved in the design of rectification equipment employed for the separation of petroleum mixtures, which are so complicated that it is impossible to recognize or measure the individual hydrocarbon constituents, was made by Wilde.

It is pointed out that the classical method of computation involved nothing but the application to any given section of the column of an energy balance, material balances for each component, and the assumption that the vapor rising through each plate comes to equilibrium with the liquid upon it. Allowance was made for failure to realize equilibrium by increasing the height of the column to correspond with an over all plate efficiency experimentally determined from measured performance of operating equipment. Wilde, enlarging on the previous work of Brown, modified this method in three important particulars. In the first place, he adopted the principle used by Leslie and Good for expressing compositions in flash vaporization of petroleum, of treating narrow boiling cuts, determined by the boiling point method of analysis, as individual components,—recognizing that, while such cuts might be relatively complex mixtures so far as ultimate constituents are concerned, the volatilities of these ultimate constituents are so nearly equal that the assumption of an average volatility for the whole does not introduce serious error. In the second place, he computed equilibrium conditions by correcting for deviations from Raoult's law by the method of Brown, thus estimating the equilibrium more accurately than was otherwise possible. Finally he rejected the classical definition of over-all plate efficiency in favor of the concept of Murphree, refining the efficiency at attainment of equilibrium on the individual plate as the amount of a

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given constituent in the vapor rising into that plate actually absorbed by the liquid upon it divided by the amount which would be absorbed were equilibrum actually obtained. On the basis of these modifications, he derived the formulas for the rectification of complex petroleum mixtures. Furthermore, he tested a commercially operating column, and showed that, except as noted in the present discussion, his equation quantitatively accounted for the results realized in practice.

In conclusion the authors state that all the data available, and their own work, confirm the conclusion that complexity of the mixture under treatment and magnitude of the deviations from Raoult's law, both tend to increase plate efficiency. They are unable to formulate a satisfactory explanation for the results, and stated that they are so striking that they should not be accepted ultimately until confirmed by further experimentation. However, it is felt that the results as presented justify the contention that the computation method developed by Wilde for the rectification of petroleum mixtures is thoroughly dependable. The unsolved problem is the development of a satisfactory technique for the analysis of petroleum mixtures, more adequate than the true boiling point still in its present state of development.

"Applications of Thermodynamics to Chemical Reactions of Petroleum Products," discussed by A. W. Francis and R. V. Kleinschmidt, Arthur D. Little, Incorporated, covered the possibilities and limitations of thermodynamic methods in the prediction of reactions of organic compounds. Equations were derived for the free energies of formation as simple functions of temperature for numerous hydrocarbons, alcohols, and related organic compounds which might be derived from petroleum. Use was made of the third law of thermodynamics, scattered data on chemical equilibria, vapor pressure, specific heats, heats of fusion, vaporization and reaction. In some cases missing and conflicting data were supplied by estimates, and the gaps thus revealed suggest opportunities for research of fundamental and technical importance. As such data are supplied, the calculations may be revised.

By combination of the free energy equations, predictions were made of the possibility of and conditions for proposed reactions. The equations also were plotted on a rational basis, permitting similar predictions by simple inspection. A graph is used to illustrate a method used in certain cases for circumventing the above simple deductions. Another plot shows graphically the synthetic possibilities of water gas. Lines on this plot show a remarkable parallelism which may simplify thermodynamic calculations for organic compounds. The writers predict that the empirical trial and error methods of petroleum chemistry will sooner or later be superseded by research based on well grounded theoretical predictions, and based on an accurate knowledge of the properties of the substances dealt with. The process of obtaining the necessary data is tedious, but the results are certain.

Dr. E. R. Lederer and R. Beattie, Texas Pacific Coal & Oil Company, in their discussion "Dewaxing of Lubricating Oils," attribute improved dewaxing methods to the phenomenal growth of aviation and the constantly increasing use of automobiles in winter. They detail a series of experiments and commercial practices in the preparation of low cold test lubricants. In conclusion the authors state, "a glance at the latest development in aero motor power will give rise to room for conjecture from the refiner's viewpoint. Packard has taken the initial step and gone into quantity production in aero-Diesel engines. Working characteristics relative to working pressure, speed and temperature are entirely different and much more severe than in a gasoline engine. Whether this new step will materially alter the existing lubricating oil specifications remains to be seen. However, we can rest assured that as the demands become more exacting in the future, they can be met as excellently as they have been in the past, secure in the knowledge that the oil business can supply any product the public is willing to pay for.

"Bright Stock Manufacture" was the topic of a paper by R. D. Evans, superintendent of the Okmulgee, Oklahoma, refinery of the Independent Oil & Gas Company, wherein the various factors affecting treatment of bright stock with sulphuric acid and contact clay neutralization were discussed. Work was done with steam refined stock continuously prepared with a battery of seven shell stills at the Okmulgee plant. Mr. Evans points out that there is a direct relationship between the acidity of acid-treated steam refined stock and the color obtained in the finished bright stock. Color is darker as the free acidity of the acid treated stock increases. The acidity of a finished bright stock will vary in proportion to the acidity of the steam refined cylinder stock. To produce a neutral bright stock from a steam refining stock high in acidity, it is necessary to make a lighter color than may be desired. The determinations were conducted using but one kind of clay, but experience with several other grades of clay seem to bear out the writer's conclusions. They have investigated some clay which shows high efficiency in neutralizing value but practically no decolorizing properties. In plant operation the color is approximately 30 per cent. better than that obtained in the laboratory.

GUM SYMPOSIUM

In the discussion "Stabilization of Knock Ratings Gums, and Color of Gasoline by Chemical Inhibitors," presented by Gustav Egloff, W. F. Faragher and J. C. Morrell, Universal Oil Products Company, the results of a study of the changes of knock rating, content of gum, and color which cracked gasoline undergoes and of methods of stabilization are reported. The authors conclude that although most cracked gasolines are satisfactorily stable during storage with respect to color, gum and knock rating, there are some that deteriorate.

There is no regularity in the formation of gum and lowering of the knock rating. The accelerated oxidation test for gum is applicable as an accelerated test for depreciation of knock rating of a gasoline. Chemical inhibitors have been found which prevent loss of knock rating during accelerated oxidation. Now chemical inhibitors have been found which prevent gum formation during the accelerated oxidation of gasoline. It is expected that they will be effective in stored gasoline. New chemical stabilizers of color for stored gasoline have been found. Processes for the restoration of

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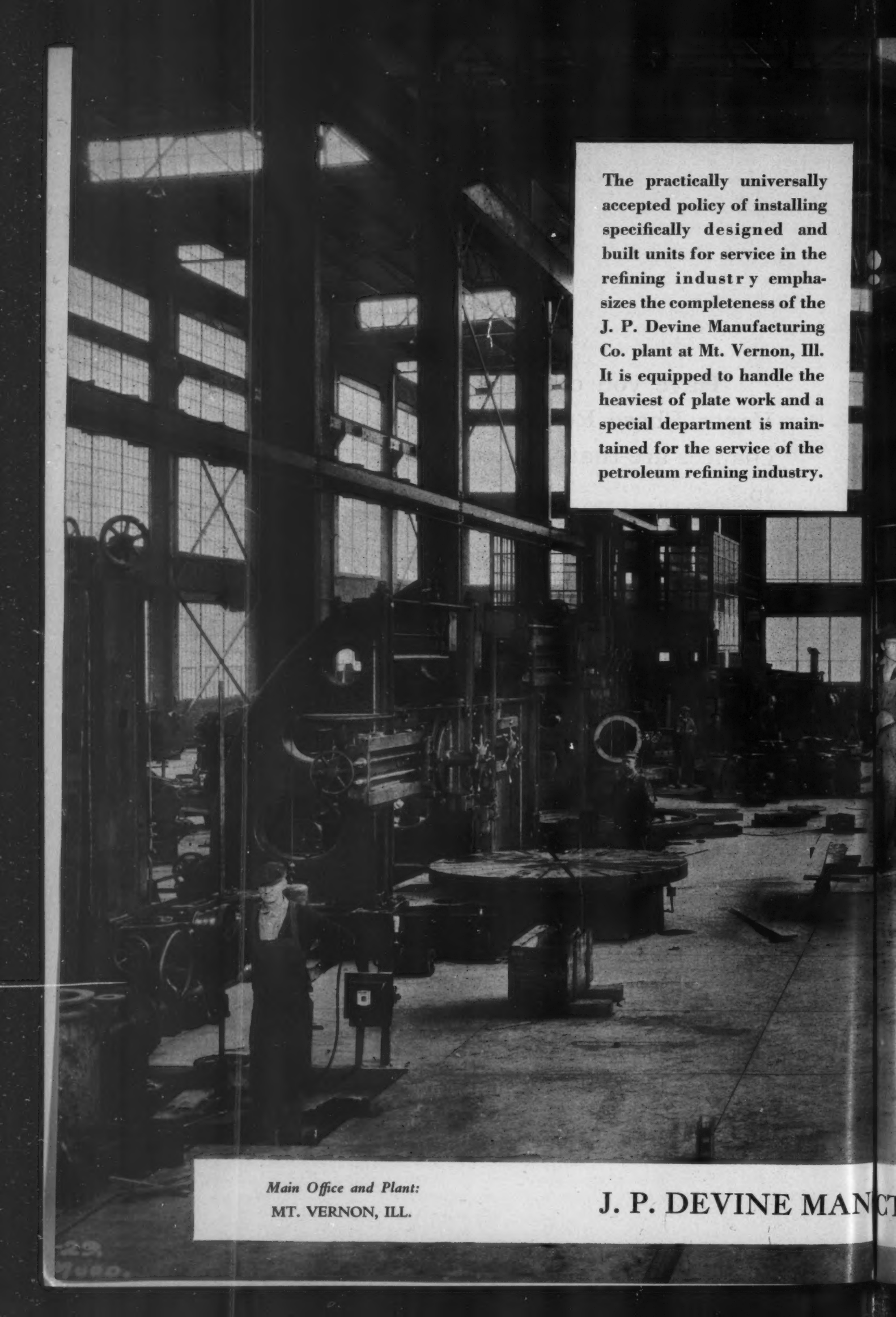

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cracked gasoline which have depreciated in knock rating have been developed.

"Factors Affecting the Determination of Gum in Gasoline," presented by C. R. Wagner and Julius Hyman, the Pure Oil Company, states that contrary to the general opinion of the uninitiated, color has little or nothing to do with gum formation in gasoline; many very yellow gasolines being gum-free while other water white samples yield large quantities of gum on evaporation. Another popular misapprehension is that gum exists as such in gasoline, but solubility and chemical tests on gum formed by evaporation show the impossibility of this. The gum forming materials which are present in gasoline are, therefore, termed pseudo-gum to avoid confusion in nomenclature. This pseudo-gum is shown to consist largely of peroxides, per-acids, aldehydes, and ketones.

After three years work the authors have chosen for routine work a modification of the Smith and Cooke test for gum, in which the steam oven is replaced by an actively boiling water bath. The copper dish test is shown to be wholly unreliable. A study of the mechanism of the pseudo-gum forming reaction shows why the evaporation of large samples in contact with air gives unsatisfactory results. This reaction appears to be based on the action of an auto-catalyst, the quantity of which increases in a geometrical proportion by atmospheric oxidation.

So far no satisfactory stability test has been developed, but indications point to the development of such a method in the near future based on selective catalysts.

E. C. Herthel and F. A. Apgar, Sinclair Refining Company, in their discussion of "Some Phenomena of Gum Determinations in Motor Fuel," stated that, briefly reviewing the situation as it stands today it might be said that attempts have been made to determine: (1) The so-called preformed or actual gum existing in gasoline at a given time, and (2) the potential gum-forming tendency inherent in the gasoline. They discussed the several methods of gum testing and the effect of metals on gums, and such phenomena as the behavior of vapor phase and liquid phase cracked gasoline in storage with metals, and their visible bowl tests. The oxygen absorption test work conducted by the authors brought out the following points: (1) The use of equipment which is entirely inert to possible physical and chemical effects is important, and (2) the presence of moisture accelerates oxidation. The use of dry oxygen or oxygen with controlled moisture concentration is essential for uniform results. The work is not complete nor conclusive, but it indicates that the gum determinations by copper dish method, steam oven method, and oxygen absorption method as practiced, cannot be correlated with each other or with storage performance where acceleration of gum formation by light or by metal catalysis is possible. Furthermore, there may be other accelerators such as moisture, which influence prediction of commercial performance by laboratory test.

New Directors Named for Institute

THE Board of Directors of the American Petroleum Institute elected the following officers for 1930:

President, E. B. Reeser, Barnsdall Corporation, Tulsa; vice president, L. P. St. Clair, Independent Oil Producers Agency, Los Angeles; vice president for production, W. N. Davis, Phillips Petroleum Company, Bartlesville, Oklahoma; vice president for refining, W. M. Irish, the Atlantic Refining Company, Philadelphia, Pennsylvania; vice president for marketing, Henry M. Dawes,* the Pure Oil Company, Chicago; executive vice president, W. R. Boyd, Jr.,* New York; treasurer, Amos L. Beaty,* Transcontinental Oil Company, New York; secretary and assistant treasurer, Lacey Walker,* New York.

The following were elected members of the executive committee:

The president, vice president, treasurer, last retired president (E. W. Clark,* Union Oil Company of California, Los Angeles), and J. Howard Pew,* Sun Oil Company, Philadelphia; R. C. Holmes,* The Texas Company, New York; W. C. Teagle,* Standard Oil Company of New Jersey, New York; Axtell J. Byles,* Tide Water Associated Oil Company, New York; F. A. Leovy, Gulf Production Company, Pittsburgh, Pennsylvania, and W. S. Fitzpatrick, Prairie Oil & Gas Company, Independence, Kansas.

The following membership committee of the board was appointed:

Roy B. Jones,* Panhandle Producing & Refining Company, Wichita Falls, Texas, chairman; Clark H. Kountz, Prairie Pipe Line Company, Independence, Kansas; W. C. McDuffie, Pacific Western Oil Company, Los Angeles; W. T. Holliday, Standard Oil Company (Ohio), Cleveland, and Herbert L. Pratt, Standard Oil Company of New York, New York.

*Re-elected.

Directors Nominated by Councillors and Elected

The Board of Councillors nominated the following candidates for directors in the groups shown, after which those nominated were elected by members of the Institute:

PRODUCTION GROUP

Pacific Coast—W. C. McDuffie, Pacific Western Oil Company, Los Angeles.

Rocky Mountain—B. B. Brooks, Consolidated Royalty Oil Company, Denver.

Central United States—W. C. Franklin, Tidal Oil Company, Tulsa; J. Edgar Pew, Sun Oil Company, Dallas; H. V. Foster, Foster Petroleum Corporation, Bartlesville; Frank Phillips, Phillips Petroleum Company, Bartlesville.

Eastern States—O. D. Donnell, Ohio Oil Company, Findlay, Ohio.

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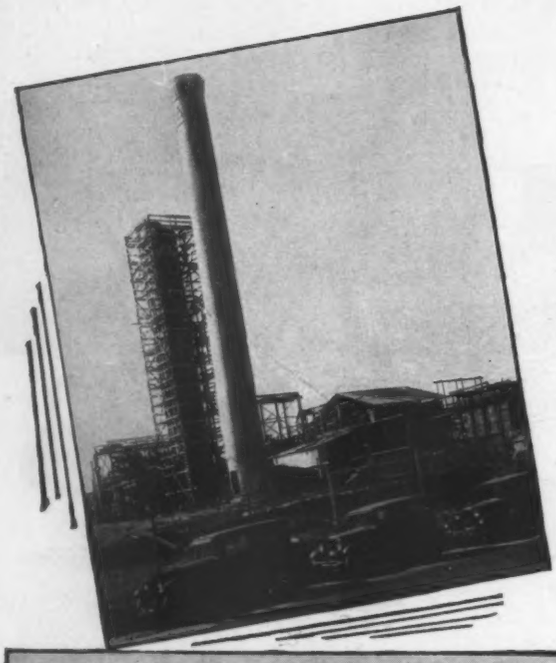

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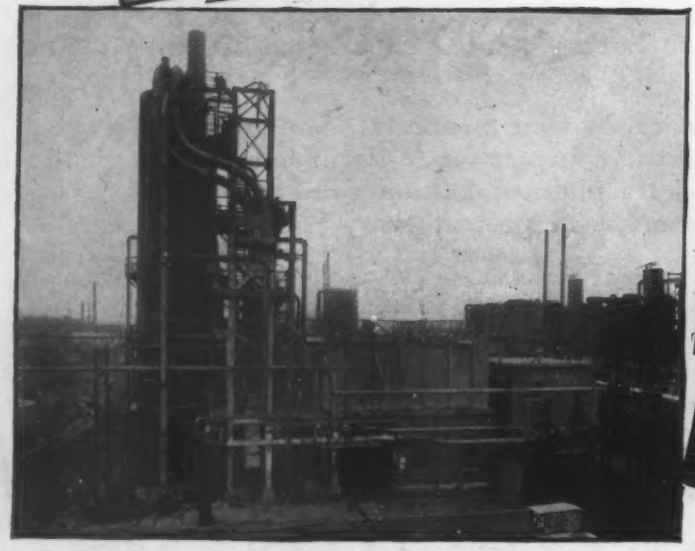

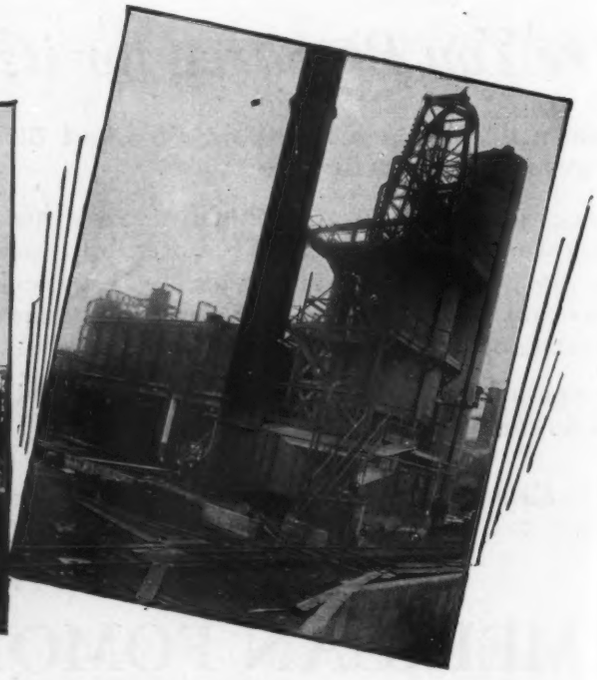

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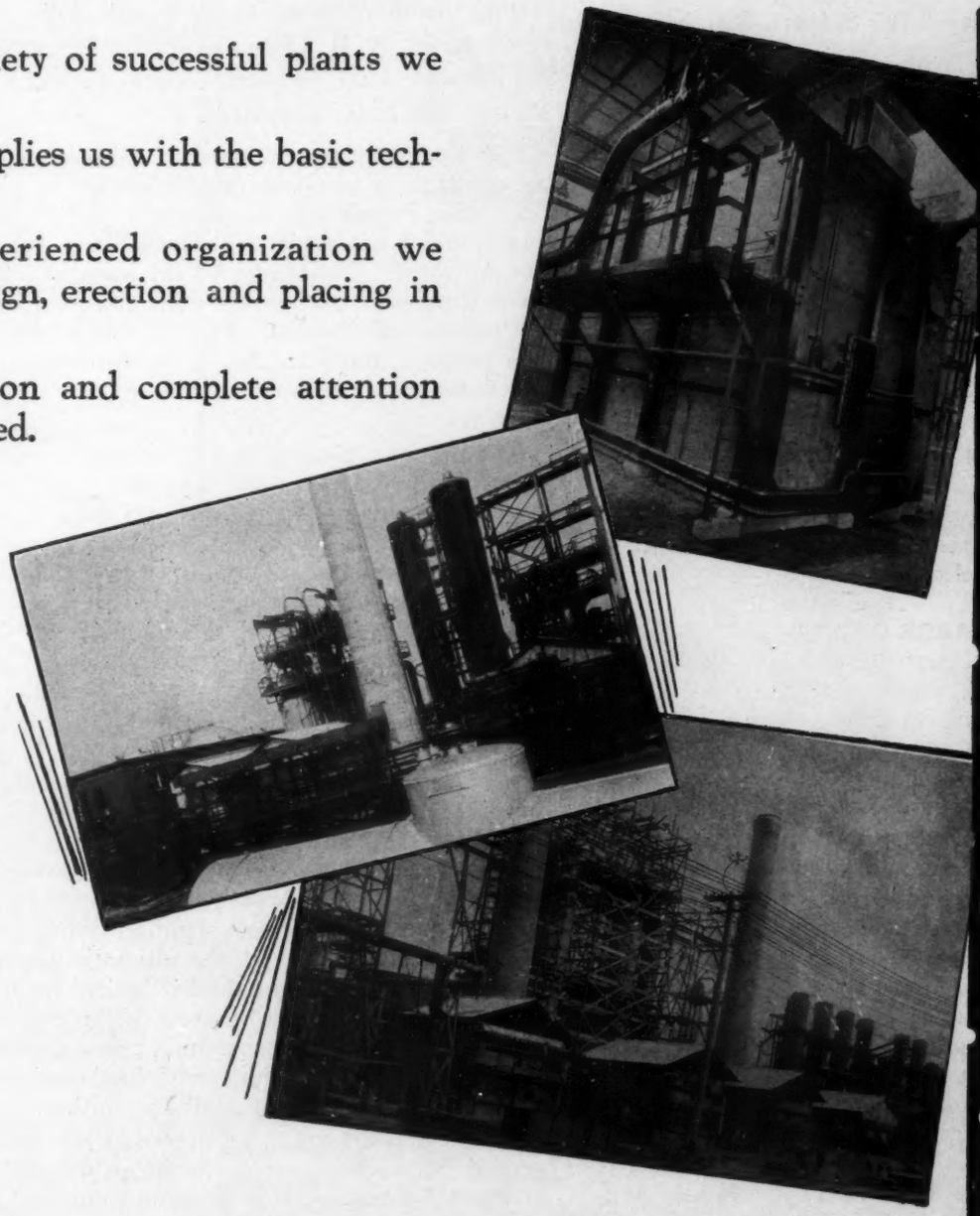

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Pierce Petroleum Corp.
Tide Water Oil Co.
Anglo-Persian Oil Co., Ltd.
Empire Refineries, Inc.
Marland Oil Co.
Vacuum Oil Co.
Associated Oil Co.
Barnsdall Corp.
Humble Oil & Refining Co.
Tidal Refining Co.
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General Petroleum Corp.
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Shell Company California
New Orleans Refining Co.
Emlenton Refining Co.
Independent Refining Co.
Richfield Oil Co.
The Texas Co.
Sinclair Refining Co.

MANUFACTURING GROUP

Pacific Coast—E. W. Clark, Union Oil Company of California, Los Angeles.

Rocky Mountain—T. A. Dines, Midwest Refining Company, Denver.

Central United States—P. M. Miskell, Empire Refineries, Incorporated, Tulsa; John L. Gray, Shaffer Oil & Refining Company, Tulsa.

Eastern United States—Charles L. Suhr, Pennzoil Company, Oil City, Pennsylvania.

DISTRIBUTION GROUP

Rocky Mountain—E. T. Wilson, Continental Oil Company, Denver.

Central United States—E. G. Seubert, Standard Oil Company of Indiana, Chicago.

Eastern United States—W. T. Holliday, Standard Oil Company of Ohio, Cleveland.

TRANSPORTATION GROUP—(TANK CARS)

Lauren J. Drake, Union Tank Car Company, Chicago.

NATURAL GAS GROUP

Henry C. Morris, Dallas Gas Company, Dallas.

NATURAL GASOLINE (CASINGHEAD) GROUP

Edgar J. Marston, Texas & Pacific Coal & Oil Company, Fort Worth.

FOREIGN TRADE GROUP

Far East—Herbert L. Pratt, Standard Oil Company of New York, New York.

Mexico and South America—C. M. Fuller, Richfield Oil Company, Los Angeles.

AT LARGE GROUP

J. F. Lucey, Lucey Petroleum Company, Dallas; E. W. Marland, Ponca City, Oklahoma; Wallace E. Pratt, Humble Oil & Refining Company, Houston; R. C. Holmes, The Texas Company, New York; T. A. O'Donnell, California Petroleum Corporation, Los Angeles; Wm. N. Davis, Phillips Petroleum Company, Bartlesville; E. B. Reeser, Barnsdall Corporation, Tulsa; H. F. Sinclair, Sinclair Consolidated Oil Corporation, New York; F. A. Leovy, Gulf Oil Corporation, Pittsburgh; J. W. DanDyke, Atlantic Refining Company, Philadelphia; Henry L. Doherty, H. L. Doherty & Company, New York.

Upon recommendation of the board of councillors, the board of directors increased the number of directors in the "at large" group by five and the board elected for one-year terms the following:

F. B. Parriot, Transcontinental Oil Company, Tulsa; C. B. Ames, The Texas Company, New York; Wirt Franklin, Wirt Franklin Petroleum Corporation, Ardmore; Waite Phillips, Independent Oil & Gas Company, Tulsa; Jacob France, Mid-Continent Petroleum Corporation, Tulsa.

In the group of directors elected by the board itself, the following were elected:

W. S. Fitzpatrick, Prairie Oil & Gas Company, Independence; E. T. Moore, Sims Petroleum Company, Dallas; H. B. Earhart, White Star Refining Company, Detroit; W. M. Irish, Atlantic Refining Company, Philadelphia.

Petroleum Accountants Society

Tulsa.—One of the best attended and most enthusiastic meetings of the Petroleum Accountants Society of Oklahoma took place November 21, in the Winter Garden of the Mayo Hotel, Tulsa. At this meeting announcement was made of the new officers chosen by the board of directors for the ensuing year. A. B. Chesebro of the Carter Oil Company was elected president; L. D. Missner of the Barnsdall Companies, vice-president, and D. B. Catterlin of the Gypsy Oil Company, secretary-treasurer. The following members comprise the board of directors: C. B. Catterlin, A. B. Chesebro, L. D. Messner, H. G. Humphreys, E. C. Stewart, C[illegible]les F. Smith, M. H. Massey and E. A. Titsworth.

The Petroleum Accountants Society of Oklahoma was organized in January, 1929, and is patterned after the Petroleum Accountants Sociey of California, which has achieved remarkable success on the Pacific Coast. Uniformity in the application of true accounting principles is the main purpose for which the society was formed. For the accomplishment of this purpose, those in charge of various accounting functions of oil companies are invited to join the society.

The principle topic of last Thursday's meeting was the reading of a paper on "Refinery Costs Accounting for Skimming and Cracking Plants," presented by C. E. Votrain of the Barnsdall Companies. This paper was prepared by the society's committee on Refinery Cost Accounting. Discussion was led by Mr. Votrain, chairman of this committee.

The committee in its paper proposed the adoption of the "single product method" of costs for skimming and cracking refineries. This method applies all the costs to the one principal product, which is gasoline. All other products are considered by-products, and the proceeds realized from the sale of such by-products are applied as a reduction of the refining cost of the gasoline. The society listened to several arguments by members who are well acquainted with refinery costs, and while no definite stand was taken on any particular method, the ultimate adoption of a uniform and standard method is looked for. To further this purpose, Mr. Chesebro designated the committee on refinery cost accounting as a committee to work with the sub-committee of the American Petroleum Institute on uniform oil accounting.

The time taken up on refinery cost accounting prevented the society getting to the paper on "Control of Plant Equipment and Material Supplies" but this paper will be discussed at the next meeting, which is scheduled for December 19. At the December meeting also, answers to about 20 questions pertaining to technical phases of oil accounting will be heard. These questions were assigned to various members of the society for the purpose of getting before the society as a body the opinions of the individual members on the subjects assigned them, with the view of arousing discussion and bringing to light new thoughts or ideas.

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REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personnel Changes

NEW LAUREL REFINERY BUILDING

The Laurel Oil and Refining Company has announced through F. H. Johnston, sales manager, plans for the construction of a million dollar oil refinery at Laurel, Montana.

The company, which was recently formed, is backed by a group of men headed by Alfred J. Deischer of Winfield, Kansas, and F. W. Camp and Roscoe Nelson of Portland, Oregon.

The plant will have an initial capacity of more than 1000 barrels of gasoline daily. It is to be erected upon a site of 103 acres recently purchased by the company.

Design, construction and operation of the plant will be in the hands of the Smith Engineering Company of Kansas City. The plant when constructed will represent one of the most modern installations in the industry, being very compact and efficient and will comprise the following general units:

A topping and reducing pipe still unit producing anti-knock gasoline and distillate and running the crude down to heavy residuum. This residuum will then be transferred hot to a modern continuous coking or asphalt plant, which will produce coke or asphalt as desired.

The latest and most efficient process for the continuous treating of the gasoline produced will be installed. Necessary auxiliaries, such as an efficient steam generating plant, refinery transfer pump house, storage tanks, office, loading rack, etc., will be supplied.

Special attention has been given in designing the plant to permit doubling the capacity with a duplicate unit in the future, and to provide for additional extensions.

The plant will be provided with an adequate fire fighting system, together with proper water mains and fire plugs. All tanks will be surrounded by suitably constructed dykes so that when completed the refinery should represent a modern installation of the highest efficiency and the most modern design of construction.

The Laurel Oil and Refining Company plans to install a complete lubricating oil plant in the future.

UTAH REFINERY EXPANDS

Utah Oil Refining Company, a subsidiary of the Standard Oil Company (Indiana), is engaged in an expansion program at its Salt Lake City refinery including the erection of new operating units and installation of equipment to effect an increase in daily capacity. Additional Holmes-Manley cracking equipment is included in this program. The project will involve the expenditure of around a half million dollars.

John C. Howard is president of Utah Refining Company. The expansion was authorized subsequent to reports of a survey of the plant made by Robert E. Wilson, chief engineer, and Dr. Walter G. Whitman of the research laboratories of Standard Oil Company, Indiana. E. S. Holt is superintendent of refinery operations for Utah Oil Refining Company. R. G. Clark is chief construction engineer.

NEW RESEARCH LABORATORY

Gulf Refining Company is constructing a new large research laboratory at Penrose and Gallows Streets, Philadelphia. Continued enlargement of the research staff and widening of the scope of activities of this department was responsible for the expanding of the facilities for conducting research work.

SIMMS EXPANSION

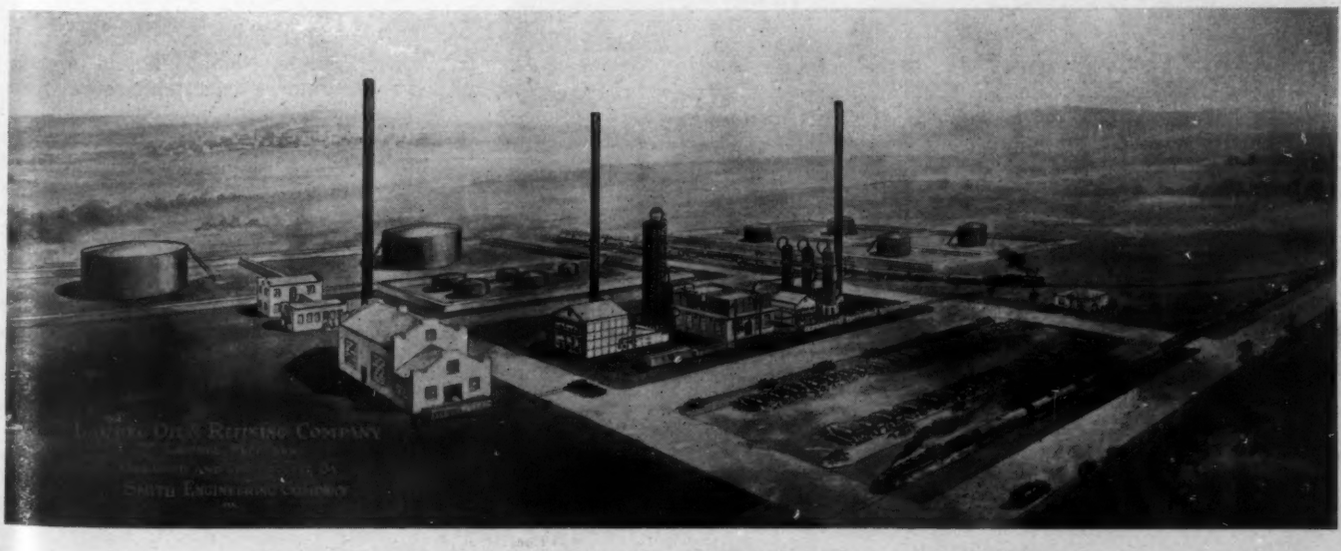
The expenditure of about $300,000 by the Simms Oil Company within the past three months on its refinery at Dallas, Texas, has materially boosted the gasoline output with a corresponding reduction in operating expense. Seven shell stills and one large pipe still have been decommissioned by Superintendent F. N. Williams through the conversion of two 600-barrel capacity units of Cross crackers into pipe stills. Two 1000-barrel capacity Cross cracking units were also changed to hot oil units, resulting in a sufficient increase in cracking capacity to offset the loss of the pair of small units. Current crude charges range from 3500 to 3800 barrels daily.

Included in the new plant work was the installation of a new 450 horsepower boiler in the central plant. The old natural gasoline absorption plant was rebuilt to afford adequate capacity in handling all still and storage tank vapors. The gasoline plant is recovering about 240 barrels of gasoline daily.

EAST CHOCAGO REFINERY TO START JANUARY 1

Crude delivery by pipe line to the new refinery of the Empire Oil and Refining Company now under construction at East Chicago, Illinois, is to start November 15 and will run to storage until the first of the year, at which time the plant is to be placed in operation. Crude will be delivered by the new Texas-Empire Pipe Line Company, running Mid-Continent oil to the Chicago area.

The plant is located in the same industrial district with refineries of the Shell Petroleum Corporation, Standard Oil Company, Indiana, and Sinclair Refining Company. The site of 372 acres which is enclosed with a six foot cy-



Laurel Oil & Refining Company's plant under construction at Laurel, Montana

clone fence, is adjacent to many trunk line railroads, on a spur of the B. & O. R. R. Main highways run on three sides of the plant.

One of the early major operations in the erection of this plant was the grading of the site. Approximately 800,000 yards of hill and fill and 3000 yards of old concrete were involved. Link Belt Crawler Cranes were employed in the grading work, which was done by A. F. Hartigan & Company, of Hammond, Indiana. The same contractor laid out roads about the plant yard and threw up dykes for the large storage tank farm.

Total tankage of 2,000,000 barrels capacity was provided. This tankage consisted of eight 80,000 barrel tanks; fifteen 55,000 barrel tanks, for tank farm. Smaller tankage consists of twelve 10,000 barrel, fourteen 5000 barrel, six 3000 barrel and twenty 11 feet by 40 feet horizontal tanks. Contract for construction of the big tanks was let to Chicago Bridge and Iron Works, and the smaller tanks were built by the Graver Corporation.

Indiana Harbor Lumber Company furnished brick for the plant and concrete was furnished by the Universal Portland Cement Company. Empire Oil & Refining Company will build the cracking plant and in this connection six late type Doherty units will be installed. The 15,000 barrel topping plant, consisting of three units was installed by E. B. Badger & Sons Company, Boston, Mass. A complete gasoline recovery plant is included in the construction. The power house was erected by the operating company. All electrical work is handled through an under ground system.

LUBRITE CORPORATION TO EXPAND

Lubrite Refining Corporation has been organized subsequent to the purchase controlling interest in Lubrite Refining Company by Vacuum Oil Company. The new company has taken over all properties formerly owned and operated by the Lubrite Refining Company, including the East Saint Louis refinery and marketing outlets.

Lubrite brand of products will continue to be marketed by the new company, which will also distribute Vacuum products through its stations and dealers. It is reported that both the refining and marketing facilities will be largely expanded in this territory.

Lubrite Refining Corporation will be under the management of the same officers as formerly. W. W. Strickland is chairman of the board; H .T. Ashton, president, and W. H. Ware is vice president.

REFINERY IN PANHANDLE

Bell Oil & Gas Company, Tulsa, has begun erection of a 4000 barrel refinery at Pampa, Texas, of the tube still and tower type, which is to be operating by March 1, 1930. High gravity crude from Gray County will be processed in the new plant. It is proposed to operate the plant under the name of Standard Petroleum Refractionating Company.

Bell Oil & Gas Company operates a 3000 barrel capacity plant at Grandfield, Oklahoma, which is equipped with Dubbs cracking units. The company also proposes to add cracking equipment at the new Pampa plant later.

Gasoline Production Increasing in Oklahoma City Pool

Foster Petroleum Corporation and Indian Territory Illuminating Oil Company, first operators of natural gasoline extraction plants in the Oklahoma City pool, Oklahoma, are expanding facilities and increasing gasoline production with the addition of two new plants. The first plant in the field was installed by these operators in Section 24-11-3, and is known as the Bodine plant. One mile east of this plant, in Section 19-11-2, these operators have completed their Button gasoline plant. Their third installation, known as the Vern plant, is located one and one-half miles north of the Button plant, and is now under construction to be completed and in operation in December. It is contemplated that these three plants will soon produce nearly 100,000 gallons of gasoline daily.

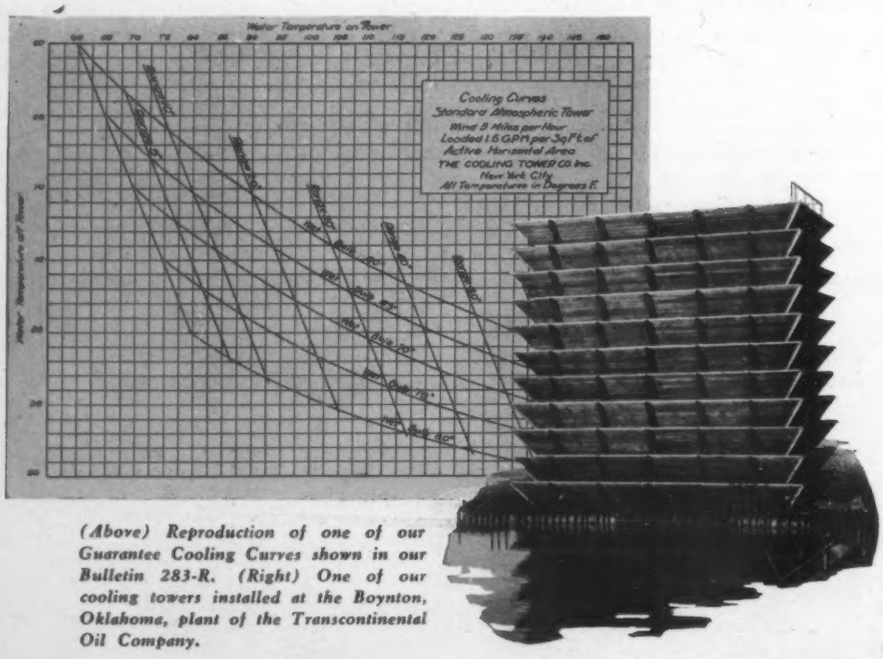
Sinclair Oil & Gas Company started operating its new natural gasoline plant

What Is This Knowledge Worth to You As a Buyer?

TO KNOW definitely, in advance, what cooling results you are going to get under any given atmospheric conditions. To know that these results are guaranteed by a company with 20 years of experience in the cooling tower field. To know that the cooling tower you buy is a carefully designed piece of engineering equipment built especially for your plant.

All these factors, and many others, are worth considering. To base your decision on price alone may prove expensive. The cooling tower which costs you more in the beginning may cost the least in the long run. From your experience you know this to be true with other equipment.

***Bulletin 283-R* should be in your files. A request will bring as many copies as you want by return mail.**


Water Temperature on Tower
Cooling Curves
Standard Atmospheric Tower
Wind 5 Miles per Hour
Loaded 1.5 GPM per Sq Ft of
Active Horizontal Area
THE COOLING TOWER CO. Inc.
New York City
All Temperatures in Degrees F.

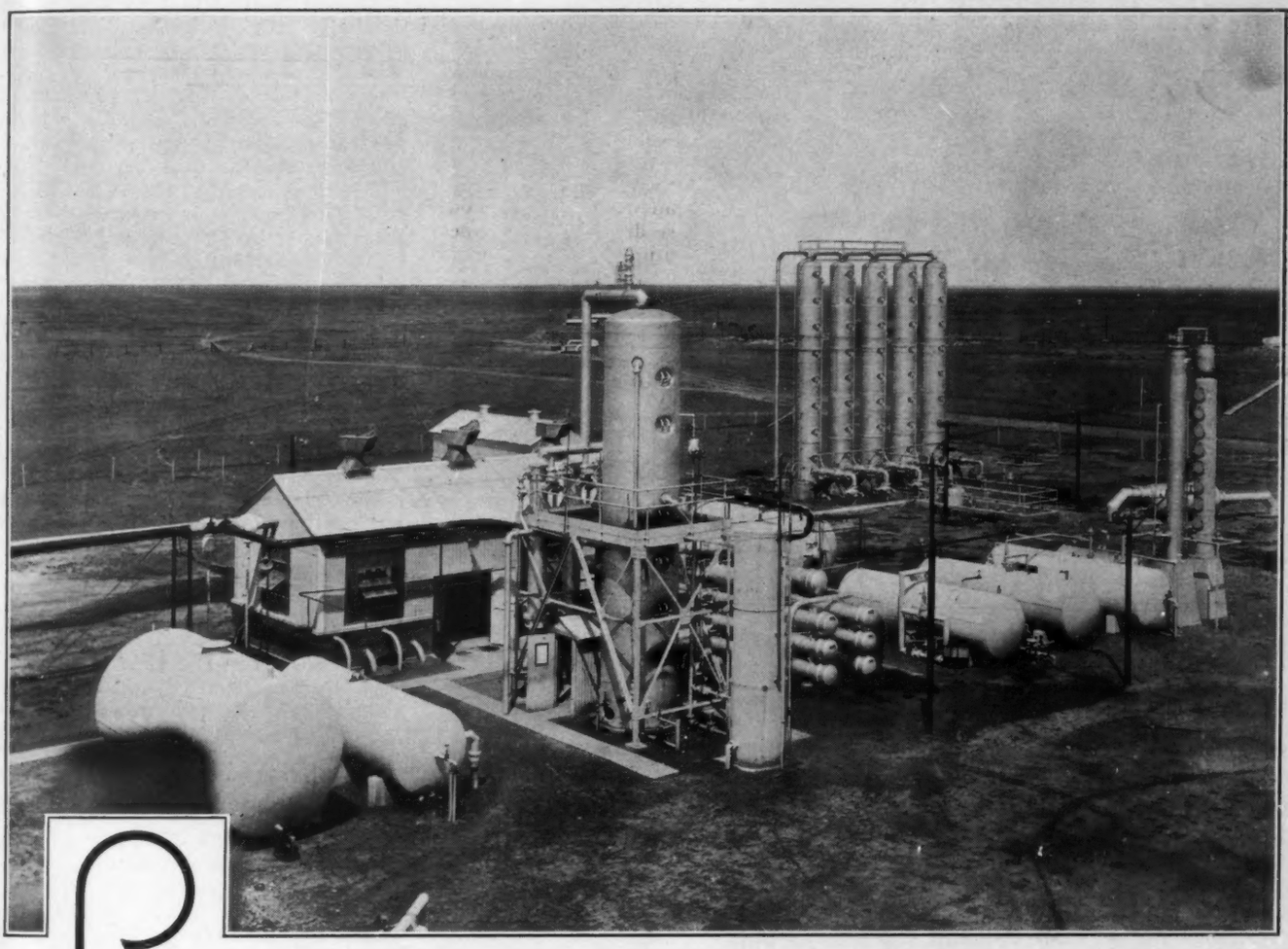
(Above) Reproduction of one of our Guarantee Cooling Curves shown in our Bulletin 283-R. (Right) One of our cooling towers installed at the Boynton, Oklahoma, plant of the Transcontinental Oil Company.

THE COOLING TOWER COMPANY, INC.

15 JOHN STREET NEW YORK, N. Y.

Distributors in Principal Cities

Absorption Plants



for EVERY SERVICE

Whether to recover gasoline vapors from low pressure gas in the oil fields, from refinery vapors, or from comparatively dry natural gas in high pressure pipe lines, Jackson Plants are carefully engineered for most economical extraction. Performance is based on the gas composition and guaranteed as to extraction and quality of product if samples can be obtained for analysis by our consulting engineers and chemists—Barton & Warner.

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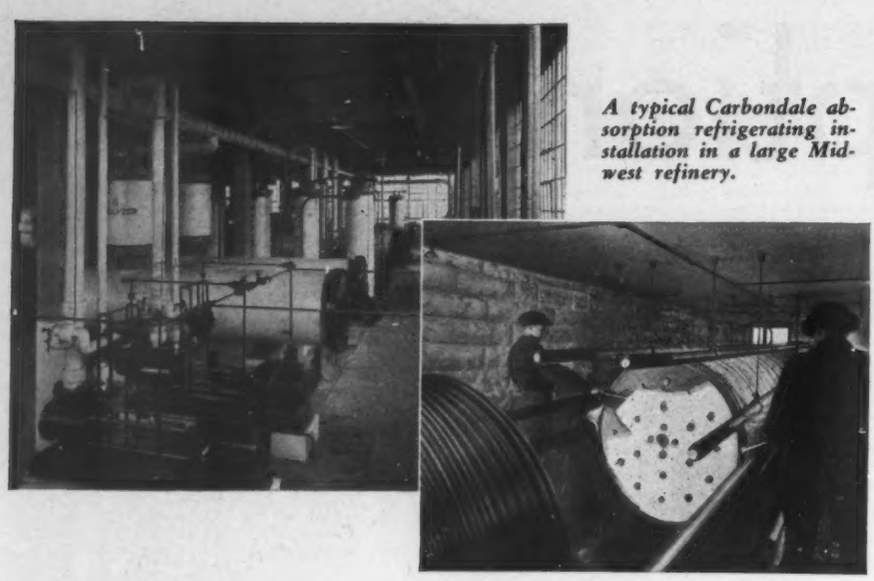
Second Natl Bank Bldg., HOUSTON, TEXAS
502 National Bank of Commerce Bldg., TULSA, OKLA.
909 East 59th Street, LOS ANGELES, CALIF.



A typical Carbondale absorption refrigerating installation in a large Midwest refinery.

Hand-in-hand

CARBONDALE Refrigerating Systems and Carbondale Filter Presses are team-mates in many of America's leading refineries. Their performance in satisfying the strenuous demands of modern refinery service is a known quantity—the anticipated output is the actual output.

Whatever the temperature and capacity requirements there's a Carbondale System for the job. Let us send you a copy of our "Wax Plant Equipment Bulletin." It's yours for the asking.

THE CARBONDALE MACHINE CO., Carbondale, Pa.
Branches in principal cities

Carbondale Refrigeration
CARMACO *for Refiners*

IF YOU HAVE A DESIRE

to use your fullers earth much longer before discard and to keep it at high efficiency after protracted use, then write us about the **NICHOLS HERRESHOFF FURNACE** for revivifying fullers earth.

G. G. Brockway Company
WARREN, PA.

about the middle of October. This is Sinclair plant No. 16, located on the Stamper lease in SE NE Section 30-11-2. Coline Gasoline Company, subsidiary of Coline Oil Company, has doubled capacity of its plant in this field.

Shell Petroleum Corporation has completed construction of a plant on the Petty lease in Section 30-11-2, and is opreating under well pressure, with a rated capacity of 15,000 gallons daily.

Gas in this field under present operating practices and conditions average about .25 to .50 gallon per thousand feet. As the field becomes older and back pressure methods of flowing are discontinued, it is expected that the natural gas production will become richer in gasoline content.

ELWOOD GASOLINE PLANT

Pacific Western Oil Company's new natural gasoline plant at Elwood, California, was recently placed in operation. The plant is located on the Spaulding property west of Elwood Terrace and has a rated capacity of ten million cubic feet of gas daily. The plant is handling gas from the first of the company's Elwood wells, which has a rated production of about one million cubic feet of gas per day which bears from three to four gallons of gasoline per thousand feet. Gasoline production when the plant started operations was reported at 3000 to 5000 gallons daily. Additional wells are being drilled which will augment the volume of gas treated by the new plant.

MIDLAND PLANT PROGRESSING

Construction work is in progress on the Midland Gasoline Company's natural gasoline plant in the Morris-Kenney field, Coleman County, Texas, with an estimated cost of $300,000. This plant will be equipped with four compressor units, and is to have a capacity of about six million cubic feet. The site is located on the White Eagle Oil & Refining Company's Morris lease, lot No. 26, Wm. Webber Survey No. 722. Contract has been made to dispose of the residue gas with the Oklahoma Natural Gas Corporation. F. C. Nickle, who maintains headquarters at Coleman, Texas, is general manager of the Midland Gasoline Company.

New Owners to Operate Yuba Oil Refinery

The Yuba Oil Refinery, Nacogdoches, Texas, has been sold to Bradley Cox and associates of Los Angeles, California, by Mrs. Phoebie Rideout for an unannounced consideration. The new owners announce they will spend $10,000 on improvements and will begin operation of the refinery as soon as possible.

The new owners also contracted for the eutire output of 30 barrels daily from the old Oil City field 17 miles east of Nacogdoches, which has been in operation for over 30 years. About 60 old wells are producing a little oil still from

Now in 100 lb. 5 Ply Paper Bags

Light 58% Soda Ash

ANOTHER forward step in a program of constant improvement — Wyandotte Soda Ash now comes in the famous Taggart-Bates multi-wall sewed-end paper bags. Five sturdy paper wrappings end the old dust nuisance. No Soda Ash sifts out—it can't.

The new 100 lb. size handles easier, quicker. You save time, labor. Guaranteed dust-proof, leak-proof, break-proof, moisture-proof.

This method of packing Light Soda Ash was originated by the Michigan Alkali Company.

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"Distinguished for its high test and uniform quality"

MICHIGAN ALKALI CO.

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21 East 40th Street, New York City

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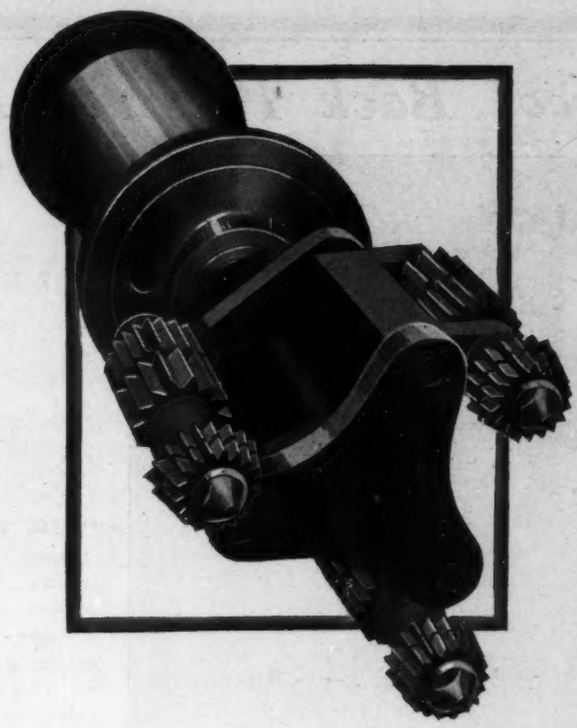


MORE POWER in the motor

FEWER PARTS in the head

This is a new Liberty Cleaner and Cutting Head built to help oil refineries speed up tube cleaning, and reduce cleaner maintenance cost.

The motor is larger, with larger cylinder displacement, and it develops from 30 to 60 per cent more power than old style machines for the same size tube. The length of the cleaner is kept as short as possible so that the cleaner will not stick in a sagged tube.

The cutter head is the new Type "L." The arms swing out sufficiently so that one head will clean all sizes of tubes within an inch range,—a 4″ head can be used for all tubes ranging from 3″ I. D. to 4″ I.D. It is of very simple construction. Arm pins and clips have been eliminated. Arms and spider are drop forged, making the head very rugged.

Motors and heads are made for large tubes,—5″, 6″, 8″, etc.,—as well as standard.

Let us tell you about them.

Liberty Cleaners

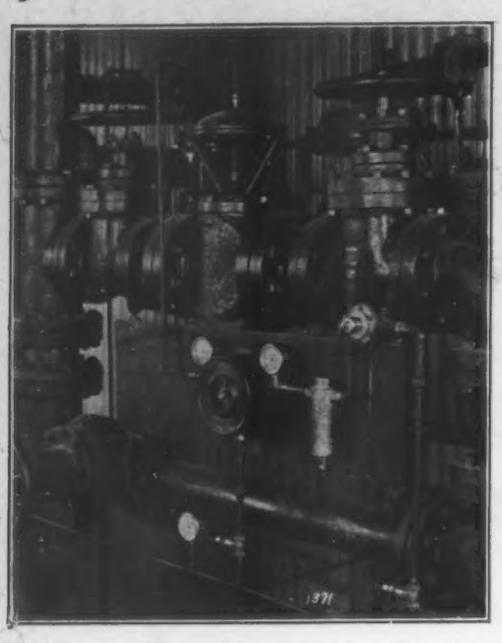
LIBERTY MANUFACTURING COMPANY

Jeannette, Pa.

Z-1087

Tycos Back Pressure Regulator

(Pilot Operated)



THE Tycos Back Pressure Regulator is a pilot operated controller, operating either by compressed air or gas. The control pressure works directly against the diaphragm and the instrument proper. This in return operates the pilot valve to release or transmit the necessary motive pressure for opening and closing the control valve.

Whereas with ordinary self-acting type of regulator, a pressure change of several pounds may be necessary to operate the controller, the Tycos Regulator affords that immediate, sensitive, and positive response to the slightest fraction of pressure change in the system under control.

Tycos Pressure Regulators can be changed from the back pressure controller to the reducing pressure regulator, by the simple exchange of pilot valves in the instrument proper. Likewise a change from a higher pressure to a lower pressure controller, or vice versa, can be made by an exchange of diaphragms in the instrument itself, where the control valve itself is suitable for different pressure operations.

Write for Tycos Catalog Part 1700 which is devoted entirely to the application of Tycos instruments in the oil industry.

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NATURAL GASOLINE PLANT DESIGN AND OPERATION

ANALYTICAL AND RESEARCH LABORATORIES

FRACTIONAL DISTILLATION ANALYSIS

the 300-500 foot horizon. It is planned to repressure the wells in an effort to make them yield more of the light oil.

Cox has also leased 37,000 acres of wildcat land and contemplates a series of wildcat tests in Nacogdoches County, the first of which is expected to be spudded in soon after January 1.

NEW VACUUM UNITS

Gulf Refining Company has closed contract for the erection of two large vacuum distillation units to be erected at its Port Arthur refinery. Standard Oil Company of Ohio has also closed contract for the construction of two vacuum units at its Ohio refineries. Foster Wheeler units are being installed by both companies.

READY MARCH 1

The new refinery near Pampa, Texas, which likely will be known as the Standard Petroleum Refractionating Company, will be completed by March 1. It will be under management identical with that of the Bell Oil & Gas Company, which maintains a pipe line system in the Pampa field and operates a refinery at Grandfield, Oklahoma.

The Pampa plant is being built for the manufacture of gasolines of the high test type. It will consist of a tube still with modern fractionating equipment. Cracking equipment is to be added later.

BUILDING REFINERY

Allegheny-Arrow Oil Company has about completed construction of a refinery at Canton, Ohio. Contract for the construction of the refinery and units for the preparation of by-products was awarded to Arthur G. McKee Company, Cleveland, Ohio. The plant will have an initial capacity of 1000 barrels. Crude is to be delivered to the plant through the Prairie Pipe Line Companies lines.

COMPLETE YATES PLANT

Humble Oil & Refining Company plans to have its new natural gasoline plant completed and placed in operation about November 15, according to late reports. The plant consists of 12 units and is the first natural gasoline plant to be erected in the Yates Pool, West Texas.

TIDAL TO BUILD AT HOUSTON

Industrial and Engineering Chemistry, News Edition, in a recent issue states that the proposed refinery of Tidal Refining Company, in the Deer Park section, Houston, Texas, is to start construction about January 1, 1930.. "Tidal Refining Company, Tulsa, Oklahoma, a subsidiary of The Tide Water Oil Company, 11 Broadway, New York, is projecting plans for construction of a new oil refinery plant near Houston, Texas, where a tract of about 700 acres of land was acquired recently in the Deer Park section. It will consist of several units, designed to handle about 15,000 barrels

An unfired fire brick in stiff mud-like form for use in boiler settings, furnace walls, kilns, etc. Far more heat-resisting than top grade fire brick.

Specify HIFIRE fire brick and get the economy of top quality.

Plastic refractories have *three jobs* to do

Install PX-33 Moldable Furnace Lining and get permanent, profitable walls, patches, linings, etc. PX-33 has been built to give *balanced* service in your furnace—doing the (1) mechanical, (2) chemical, and (3) refractory job. Shipped in steel, interlined drums.

Our Catalog 141 tells *how* and *why:* write for your free copy today.

THE DENVER FIRE CLAY COMPANY
DENVER DFC COLO. U.S.A.
BRANCHES AT SALT LAKE CITY, EL PASO, AND NEW YORK

HAVING GASKET PROBLEMS?

LET US SOLVE THEM FOR YOU!

We make metal gaskets of any size or shape, plain or corrugated, with or without asbestos, also plain solid washers of copper, aluminum, monel metal or any material desired. Our Gasket Guide shows a very complete line of gaskets suitable for refinery work.

Copy sent upon request.

GOETZE

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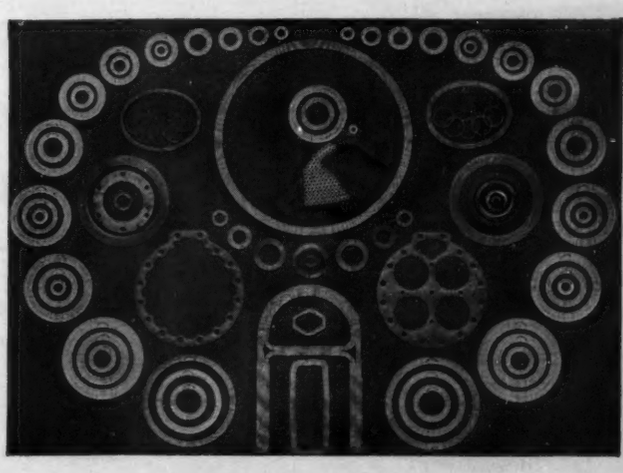

A Few Types of Goetze Gaskets

MODERN PRACTICE

"RAPID CONVERSION"
... aided by Refrigeration

FROM the moment when high temperatures have ceased, the conversion of crudes into the various lubes is accelerated by artificial refrigeration.

Time was when zero tests waited for zero weather. But now-a-days, the shortest distance between the oil well and the retail distributor lies along the path pioneered by such refrigeration engineers as are found on the staff of this Company.

Since 1867 Vilter precision products have established standards... since 1882 Vilter chilling methods have influenced the entire development of refrigeration... today Vilter equipment dominates the field.

Nowhere will you find engineers possessed of a better understanding of your chilling problems. The entire Vilter staff is ready to cooperate with your engineers to the fullest degree. Write, now, for details.

The Vilter Manufacturing Co.
1099 Clinton Street
Milwaukee, Wis.

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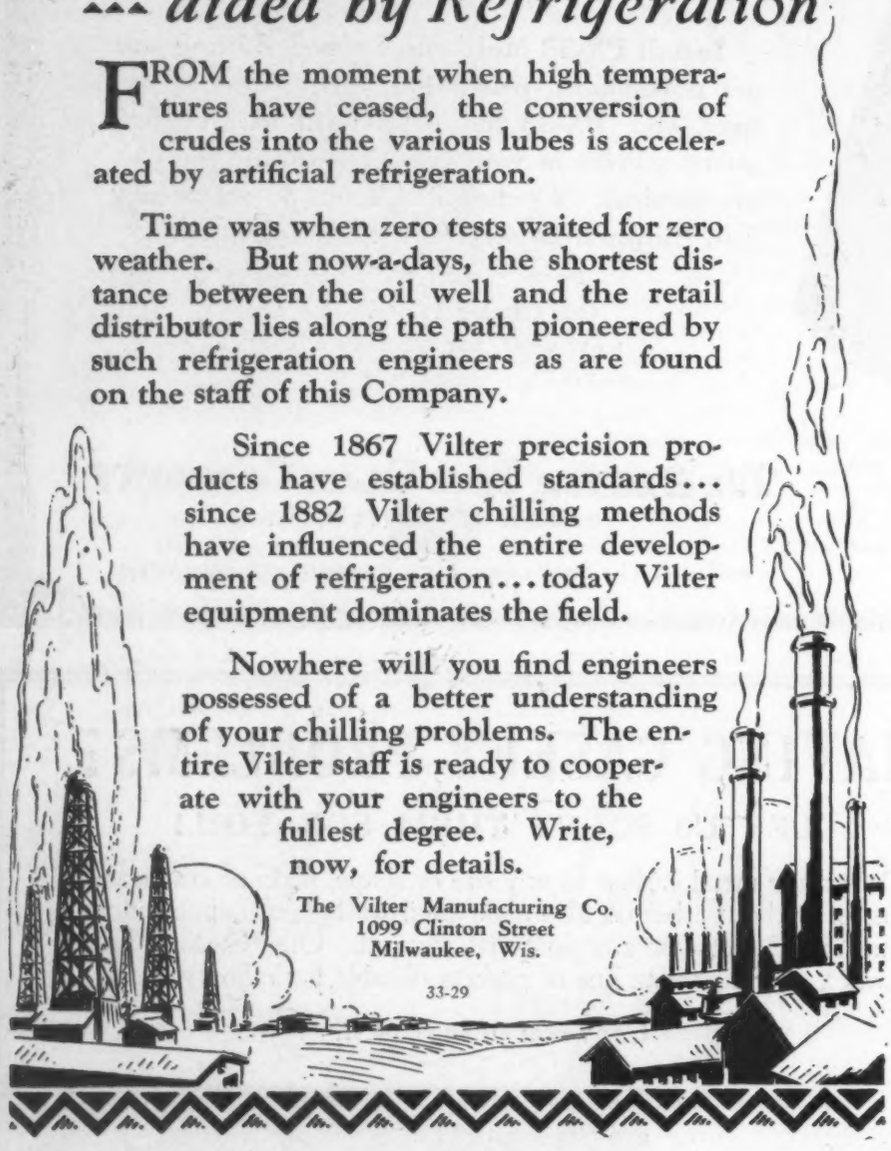


The Spiral Motion Is the Trick

That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request

B. MIFFLIN HOOD CO., DAISY, TENN.

of crude oil daily, and reported to cost more than $2,000,000, including machinery. It is understood that the work will be placed in progress within 30 to 60 days. Edward Ellsberg is chief engineer for the parent organization."

GREENFIELD TO TRINIDAD

G. M. Greenfield, formerly assistant superintendent of the Havana, Cuba, refinery of Standard Oil Company of New Jersey, has been appointed superintendent of the new La Brea refinery on the island of Trinidad, B. W. I. L. L. Kennedy is assistant superintendent.

The plant was built on the unit plan, to allow for future expansion of all facilities. Present capacity rating is 500 barrels and is operating on production from the island area which is called Palo Secco, the highest grade, and San Franceque and Flyzabad. Facilities are provided for loading deep water vessels.

NEW JERSEY REFINERY

Chemical and Metallurgical Engineering reports that Standard Oil Company of New Jersey has had sketches made of an oil refinery, oil storage tanks, buildings, etc., to be erected at Kreischerville (Staten Island) and that the estimated cost is one million dollars.

SHELL PLANT IN CANADA

Shell Oil Company of Canada, 276 St. James Street, Montreal, is having plans prepared for the construction of a refining installation to be erected at Collingswood, Ontario, to cost $500,000.

ARKANSAS PLANTS ENLARGE

McMillan Petroleum Corporation is building a 2000 barrel pipe still at its El Dorado, Arkansas, refinery located in Section 32-17-15.

Henry H. Cross Company is building a 1500 barrel capacity pipe still at its refinery at Smackover.

ACME ENLARGING

Acme Refining Company, 3591 West 56th St., Cleveland, Ohio, manufacturer of greases, lubricants, etc., plans early construction of a two-story addition to its plant, reported to cost $125,000, including machinery. T. R. Wash is president of the company.

ILLINOIS REFINERY

Henry H. Cross Company, Chicago, is erecting a small refinery in the new field at Dupo, Illinois. Estimated cost of the plant is placed at $125,000 including tankage. This is the first refinery for the district.

Standard Oil Company of Pennsylvania, Peoples Gas Building, Pittsburgh, is building a refinery, compounding plant and bulk station, including four 90 foot tanks, storage buildings, etc., in Beaver County, Pennsylvania. Contract for tank erection has been let to Ritter-Conley Company.

EMPIRE OIL METERS

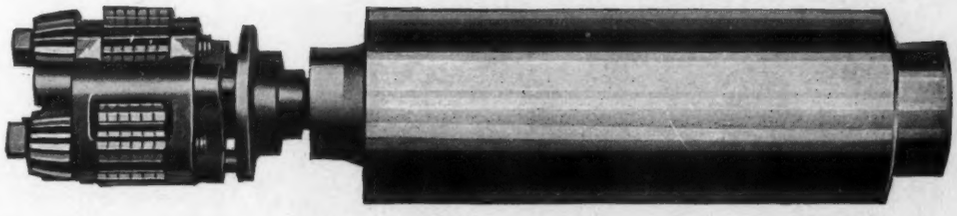
The EMPIRE Oscillating Piston Meter is the best and most convenient instrument procurable for accurate measurement of oils, gasoline, and other liquid petroleum products. It has no equal for pressure still work, and all other measuring requirements of the refinery. EMPIRE meters are made in all sizes, from 5/8 to 6 inches, inclusive. Standard types will withstand a pressure of 150 lbs. to the square inch. High pressure types will handle up to 300 lbs. Meters for still higher pressures, and special types for special purposes will be built to order. The vertical dial as shown here, can be turned to face in any one of four directions. The hands can be set back to zero after any single run without disturbing the total of all the runs, which is recorded on a straight-reading register in the lower part of the dial face. Standard horizontal, straight-reading registers can be furnished if preferred.

EMPIRE meter accuracy has never been surpassed by any other meter, and what is more and better
THEY *STAY* ACCURATE

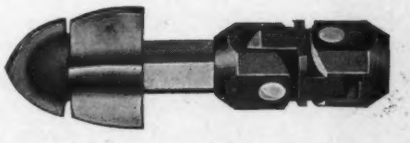
Send for fully illustrated descriptive EMPIRE circular No. 110-R

National Meter Co.
299 BROADWAY, N. Y.
Established 1870

ROTO TUBE CLEANERS



Roto air-driven Cleaner for Oil Still Tubes, made in sizes for 3″ tubes and larger.



Roto Still Type Drill Head

Roto Unit Drill Head

THE ROTO CO. Sussex Avenue and Newark St., NEWARK, N. J.

Richfield Acquires Rio Grande

With the acquisition of Rio Grande Oil Company, Los Angeles, the Richfield Oil Company of California, Los Angeles, secures valuable producing properties in California and Texas, and four more refineries. Rio Grande has been operating plants at Vinvalle, California, Phoenix, Arizona, El Paso, Texas, and Sour Lake, Texas, and operates two natural gasoline plants at Santa Fe Springs and Long Beach, California, with a combined daily capacity of 60,000 gallons of gasoline. In addition, Rio Grande Oil Company has extensive marketing facilities in California, Arizona, New Mexico and Western Texas, and a modern loading terminal at Long Beach. Richfield Oil Company recently acquired controlling interest in Tiona Refining Company, operating a complete refinery in Pennsylvania.

NEW EASTLAND GASOLINE PLANT

Midland Gasoline Company, Midland, Texas, plans the installation of a new four unit natural gasoline plant near Coleman, Texas.

NEW VENEZUELAN PLANT

The Venezuelan government has granted permit to the Venezuelan Royalties Corporation for the immediate construction of a refinery to be located on the Paraguana Peninsula. The site was acquired from Pantepec interests and the plant will cost around $2,000,000 for the first 10,000 barrel topping unit. It is planned later to install a second 10,000 barrel unit and Dubbs cracking units. Contract for construction of storage facilities totaling 320,000 barrels capacity and 2200 feet of loading pier has been let to Southwestern Engineering Company. Crude will be transported from Lake Maracaibo to the refinery by means of shallow draft tankers. David C. Reid, Inc., New York, will market the company's products.

Refinery for Savannah

Mexican Petroleum Company, Ltd., subsidiary of the Pan-American Petroleum and Transport Company, New York, is reported to be planning the construction of a new refining installation at Savannah, Georgia. The estimated cost is placed at one million dollars.

Fomon Equipment Used at Naval Station

Fire fighting equipment of the American Fomon Company, Drexel Building, Philadelphia, illustrated here is that furnished the United States Navy for the protection of naval oil storage at Cavite, Philippine Islands.

The carrying unit especially designed in this instance employes steel wheels in order to meet local conditions, although rubber tired wheels are furnished and such other modifications necessary to meet the particular conditions.

The unit as shown is capable of carrying a live load of 13,000 pounds, consisting of 10,000 pounds of Fomon generator chemicals, three Fomon generators, one Fomon portable tower, 800 feet of hose and all tools and incidental equipment necessary.

The riser, also shown here, is removed from the top of the carrying unit and the hose is taken out of the rear over a roller, after which the generators are removed for insertion in the hose lines at convenient points.

Construction of the unit is entirely of steel. The suspension is low so that travel over rough roads or open country is possible.

A supply of water is all that is necessary to have a complete foam extinguishing system.

A feature of this method of coping with fires is the flexibility of operation. The generators may be located outside the dyke and the chemicals fed a sufficient distance from the fire to assure safety for the operators. Anyone of the generators may be used with a single hose line and nozzle to combat incidental fires in the vicinity.

The portable foam tower is sufficiently light in construction that it may be carried over the dyke and placed against the storage tank. The tower is made of nickle chromium iron alloy, to afford a heat resistance and the corrosive action of chemicals or the weather.

Fomon Equipment used by the Navy in Philippine Islands

Anderson-Pritchard Corporation, Colcord Building, Oklahoma City, plans installation of new refinery equipment to involve an expenditure of $100,000.

Indiana Oil & Gas Company (Grayburg Oil Company), San Antonio, Texas, is having plans prepared and drawings made for the construction of a refinery on property purchased some time ago for this purpose. Hope Engineering Company, 149 Broadway, New York, is engineer. Estimated cost is one million dollars.

CRUDE FOR ILLINOIS PLANT

The Texas-Empire Pipe Line Company has entered into contract with the Globe Refining Company of Illinois for the delivery of 5000 barrels of Mid-Continent crude daily to the Globe refinery at Lemont, Illinois. Delivery is to start during November and the plant will start treating the new crude December 1. The Lemont plant has been operating on Michigan crude for the past several months. D. B. Kelly is superintendent of refinery operations.

NEW PLANT FOR CONNECTICUT

It is reported that Atlantic Refining Company, 260 South Broad Street, Philadelphia, Pennsylvania, plans the early construction of an oil refinery at New Haven, Connecticut, at an estimated cost of one million dollars. At the same point the company will erect a lrge, modern distribution station at a cost of a half million dollars.

Installation work on the cracking units of the Shell Petroleum Corporation's new refinery at Deer Park, on the Houston Ship Channel, probably will not be completed until January 1, according to R. B. High, superintendent in charge.

Since August 6 the plant has operated solely as a topping plant, pending completion of further construction work. It is using principally West Texas crudes, handling them through three pipe stills and tower hook-ups of Shell design.

WEST TEXAS CRUDE

We are in a position to contract for tank car shipments for immediate delivery. Deliveries made f. o. b. cars at McCamey, Texas, on basis Humble Oil & Refining Company's posted prices for West Texas crude of like gravity plus customary gathering and loading charges—in lots of 1,000 to 10,000 barrels daily.

This is Taylor-Link and Girvin fresh crude of 29 to 32 gravity, having sulphur content of approximately 1¼ per cent, being the lowest sulphur content crude in West Texas.

We will be able to help you obtain some very attractive transportation rates. Suggest you wire us, Petroleum Building, your requirements immediately.

Landreth Production Corporation

Producers of West Texas Crude

Fort Worth, Texas

A *Few* Degrees Make a *Big* Difference!

Their ability to withstand a few more degrees of heat has kept Evens & Howard Fire Brick in the lead for nearly three quarters of a century and made them the logical choice when steady, high furnace temperatures must be maintained for days, weeks and months. You are buying more than mere fire brick when you purchase from Evens & Howard—you are investing in the proven products of one of America's oldest refractory manufacturers.

Clays used in making Evens & Howard fire brick are from our own extensive mines in Missouri, Texas and Georgia: They include all varieties of plastic and flint fire clays, high alumina diaspores and kaolins. Among the following eight specialized brands of fire clay brick, you are sure to find one exactly suited to your special requirements and which will successfully meet the severest furnace conditions known under modern industrial methods.

TEXAFRAX DURAFRAX *Made in Texas*	ACME, ST. LOUIS VULCAN, VULCAN ★★★ *Made in Missouri*	KAOFRAX VOLCANO *Made in Georgia*

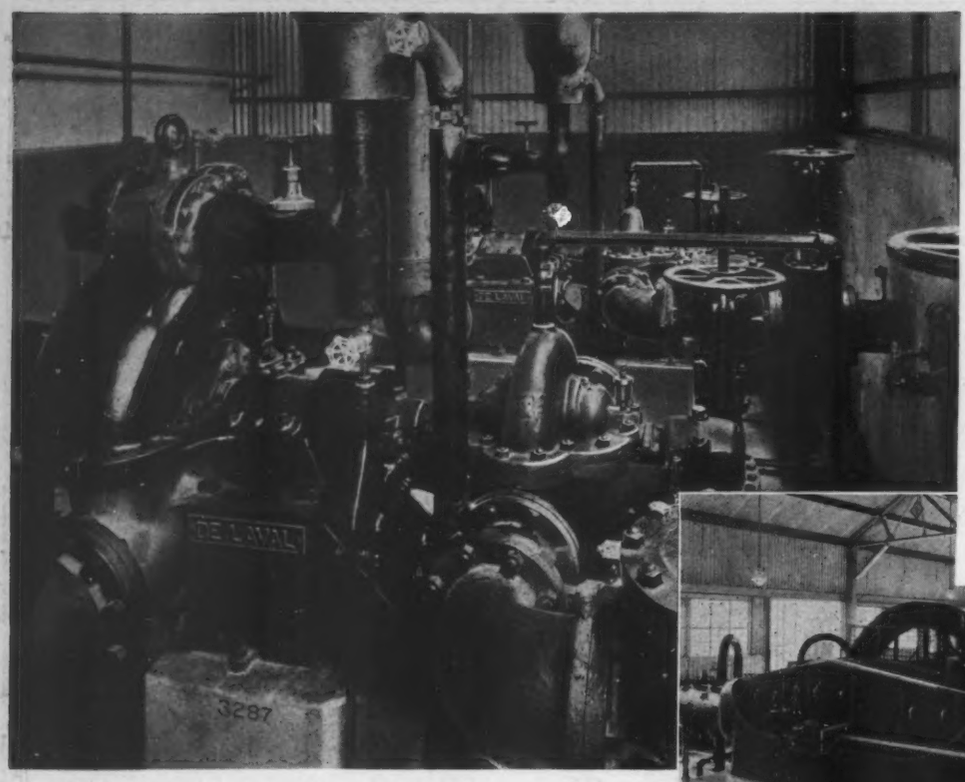
EVENS & HOWARD FIRE BRICK COMPANY

Main Office and Plant, ST. LOUIS, MO.

TEXAS CLAY PRODUCTS CO.
Plant, Malakoff, Texas

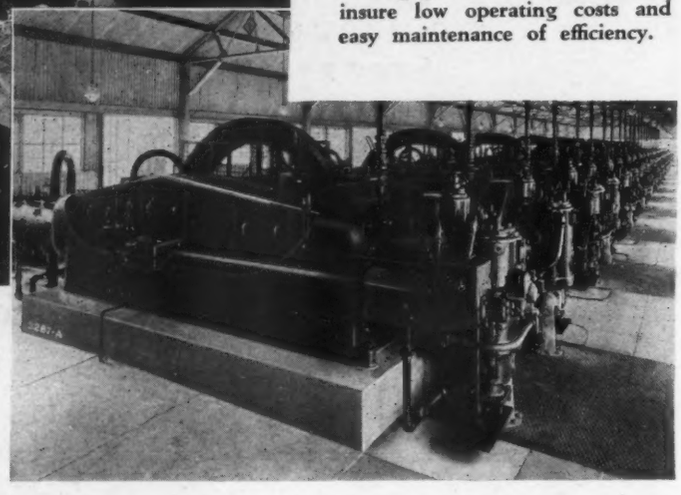
EASTERN OFFICE
11 Park Place, New York

STEVENS, Inc.
Plant, Stevens Pottery, Georgia



Continuous Night and Day Service

These De Laval Turbine driven Centrifugal Pumps supply jacket cooling water to 52 reciprocating compressors, installed in a large oil refinery. In another similar installation the De Laval circulating pumps have run continuously night and day for 23 months. The design, materials and workmanship of De Laval pumps give the utmost in reliability. Removable labyrinth wearing rings, shaft protecting sleeves and casing protecting bushings, with construction on a limit gage interchangeable basis, insure low operating costs and easy maintenance of efficiency.



De Laval Steam Turbine Co.,
Trenton, N. J.

Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Reduction Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery.

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"EVERYTHING FOR MINE AND INDUSTRIAL SAFETY"

NEW EQUIPMENT, CATALOGS, BULLETINS, BOOKS

Tulsa Type Evaporator

TULSA BOILER & MACHINE COMPANY

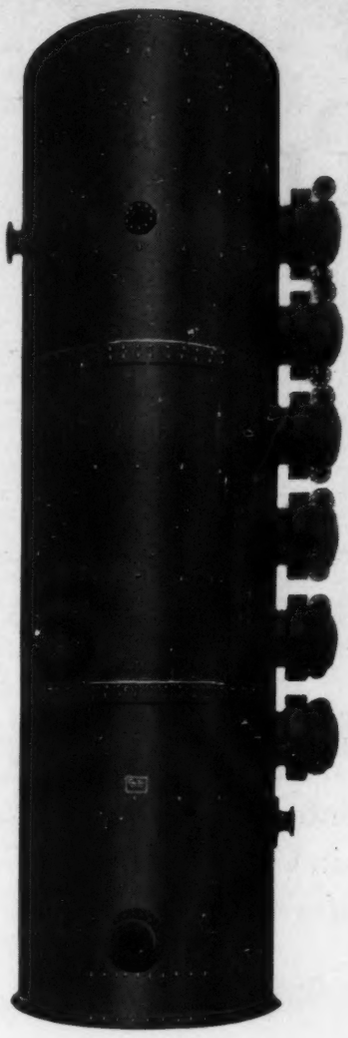
The latest addition to the Tulsa Type line of gasoline plant equipment is the new Tulsa Type Evaporator with built-in heating elements. This evaporator is covered by patents No. 1695192 and No. 1637947, with other patents pending.

The outstanding feature of this new piece of equipment is the built-in heating elements which do away with the old method of heating on the trays for evaporation. The bottom tray, which determines the efficiency of an evaporator, is hottest, thereby increasing the efficiency of the heating elements due to greater M.T.D. It eliminates the necessity of insulating preheaters and the use of a vent tank before preheaters, thereby saving the radiation losses that would occur from these pieces of equipment.

In addition the oil passes to the exchangers at a higher temperature, thereby increasing evaporation in exchangers themselves, which in turn increases their efficiency due to this evaporation establishing a greater M.T.D.

The result is a saving of open steam of not less than 20 per cent. A saving of 10 per cent. due to reduced radiation losses and a saving of in excess of 10 per cent. due to increased heat exchanger efficiency, thereby making a total of 30 per cent. saving in steam consumption when operated at the same pressure. Or the equipment can be operated at a higher pressure, thereby increasing the efficiency of the condensing coils resulting in a large saving on this equipment and also on the recompressor load.

More information may be had by addressing Tulsa Boiler & Machinery Company, Tulsa, Oklahoma.



Tulsa Evaporator

Pipe Couplings

OIL CONSERVATION ENGINEERING COMPANY

OCECO couplings have been perfected to secure tight joints with a minimum of time and labor in pipe-lines, coils, or any piping system. The couplings are unaffected by oil, gas, tar, water, or steam, and withstand temperatures of to 900 degrees F. and pressures up to 150 pounds.

The coupling consists of a split housing, a pair of bolts, and a packing ring. Housing is made of certified malleable iron to provide for resistance to corrosion and is so designed as to secure maximum strength with minimum weight. The standard packing ring is of molded asbestos, and other materials are provided to meet special conditions.

The coupling is quickly assembled by slipping the packing ring over the pipe ends and bolting the two half housings over the ring. There is sufficient play to allow for expansion and contraction of the pipe joint. The couplings are made for use with groove pipe, which can be secured from any pipe mill and at less cost than threaded pipe.

OCECO Couplings

Oceco couplings are well adapted for use in making up coils such as condensers, coolers, heat exchangers and general pipe laying.

Further information can be secured from The Oil Conservation Engineering Company, Cleveland, Ohio.

New Rubber Gas Mask

BULLARD-DAVIS, INC.

Bullard-Davis, Inc., manufacturers of first aid and safety equipment, has developed a new Red-D rubber face piece for gas masks. The new Red-D rubber offers a marked increased tendency to hold its shape.

The exhalation valve is designed to lend improvement to the mask. It is set at right angles well up under the chin so as not to interfere with the head motion in any direction.

Bulletin No. 201, describing the Davis gas mask, Type M-1, canister worn on breast, and Bulletin No. 202, Type M-0, worn on back, has just been published and is ready for distribution.

The Duriron Company, Inc., Dayton, Ohio, has mailed out Bulletin No. 155, describing the Duriron centrifugal pump, Series No. 75 and No. 80, direct motor drive. Copy of this bulletin, which describes the products with illustrations in photographs and drawings, is available by writing the manufacturers.

Schutte & Koerting Company, Philadelphia, has just published a bulletin illustrating in condensed form the equipment built for steam power plants. While the bulletin is not strictly speaking, a catalog, it gives some interesting information on steam power plant auxiliaries. A copy will be mailed upon request to the company. It is Booklet No. 1, and contains 28 pages of description and illustrations.

IDLING DEVICE FOR GASOLINE WELDER

An automatic idling device or throttle control for regulating speed of engine in Lincoln Stable Arc welders of the gasoline engine driven type has recently been perfected by The Lincoln Electric Company, Cleveland, Ohio. The new device automatically increases the speed of the engine from normal idling speed to the proper speed for welding service whenever the arc is struck. When welding is discontinued, the device automatically reduces speed of engine to normal idling speed.

The operating mechanism of the device consists principally of a small metal bellows and an electric magnet. When the arc is struck the armature of the electric magnet opens a relief valve in the bellows causing them to inflate which in turn allows a coil spring to open the engine throttle. When the welding operation ceases,

The Edeleanu Process

Refine your distillates with liq. SO_2 and avoid

Inferior finished products

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Special Burner for Gasoline Plant and Refinery work.

Burns the richest of gas with a short flame.

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TULSA, OKLAHOMA

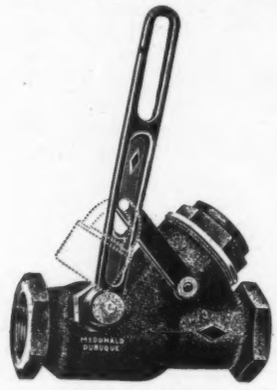
the bellows are deflated by suction of engine intake, thus causing the closing of the engine throttle to idling position. The idling device is provided with a control lever which may be set for automatic throttle control, for continuous idling speed or for governer speed.

The device is so designed that a momentary interruption in welding will not cause a reduction in speed of the engine.

Line Valve

A. Y. McDONALD MANUFACTURING COMPANY

The A. Y. McDonald Manufacturing Company, Dubuque, Iowa, is now marketing its self-closing line valve, which has a slow closing action, secured by the presence of liquid in the dash pot, which acts as a cushion, giving the valve its slow closing feature and eliminating the shocks and jars on the manifold and line which are the chief causes of leaks.



McDonald Line Valve

The belly in the valve has been eliminated by placing the valve and seat at an angle of 30 degrees instead of 90 degrees. This provides that the liquid does not have to drop down and rise again into the line. In this way restriction and friction are cut to the minimum and a straight water course is secured.

The stuffing box is on the non-pressure side, to eliminate leaks at this source. It also is designed to provide a convenient locking arrangement.

This self-closing line valve is made with an all brass body in two, two and one-half and three-inch sizes.

Additional information on this valve is available through the company at the above address.

Bronze Bearing

JOHNSON BRONZE COMPANY

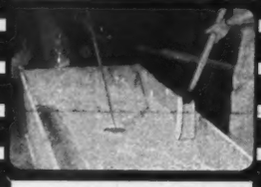
Johnson Bronze Company, New Castle, Pennsylvania, manufacturers of bronze bushings, bronze bearings and bronze castings and cored and solid bar bronze, recently announced a new self-lubricating bronze bearing.

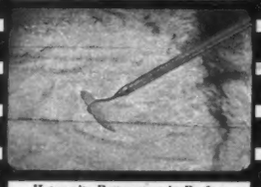
It is designed and constructed to provide a uniform area of bearing surface on the pressure line, and to insure an efficient distribution of lubricating compound.

A new method of effecting indentations in the metal and by placing them

Hytempite comes sealed in steel

Always ready for use


Thinning to a Pancake Batter


Hytempite Batter stays in Perfect Suspension

Cut Down Fire Brick Replacements with

HYTEMPITE

(Reg. U.S. Pat. Off.)

The all-temperature Fire Brick Cement

—is easy to use
—makes a thin joint
—permits hot patching
—comes sealed in steel
—reduces amount of fuel consumed
—insures reduction of heat losses
—makes a tough bond throughout the wall
—resists destruction from constant vibration
—eliminates the possibility of shrinkage cracks
—expedites repairs—prevents long shut-downs
—allows furnace operation at high temperatures
—air sets and does not depend on heat for strength
—makes a perfect seal—prevents infiltration of air
—retains strength at temperatures at which fire brick fail
—is ideal refractory when used with crushed old fire brick
—can be shot in place with a Quigley Refractory Gun.

Ask for Bulletin R 252.

QUIGLEY FURNACE SPECIALTIES COMPANY INCORPORATED

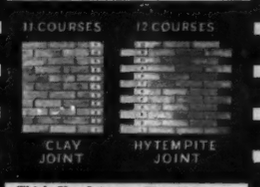
56 West 45th Street New York

REFRACTORY MATERIALS FOR FURNACE CONSTRUCTION AND MAINTENANCE
ACID PROOF CEMENTS ACID AND ALKALI PROOF COATINGS

Stock and Service through Agents in Every Industrial Center

Shows thin joint obtained

Laying wall with Hytempite



Thick Clay Joints vs. Thin Hytempite Joints

Hytempite Joints have great strength

a. c. f. Tank Car built to
I. C. C. Specification No. 103

A. C. F. Tank Cars—all classes for all commodities

New Designs to Meet the Latest I. C. C. and A. R. A. Specifications

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American Car and Foundry Company

CHICAGO 30 CHURCH ST., NEW YORK ST. LOUIS

IN THE SERVICE OF THE NATION'S RAILWAYS. HIGHWAYS, WATERWAYS, INDUSTRIES

on an angle of 30 degrees is described as obtaining the improved results.

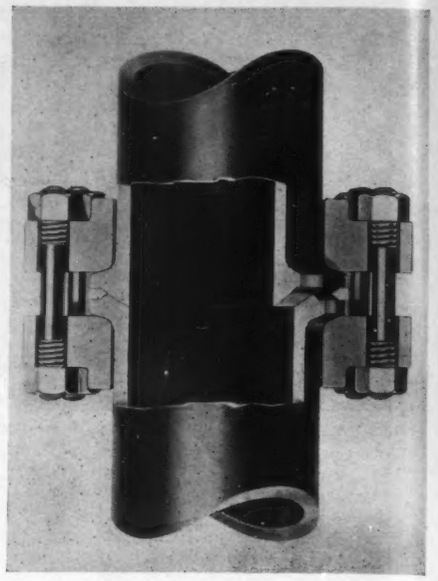
The new design in this bronze bearing is for use especially by manufacturers of machinery and parts subject to intermittent or periodical operation, such as brake levers, clutch levers, shock absorbers, rocker arms, slow running journals, starting motors, landing gears, guide rollers and sliding door rollers.

The U. S. Stoneware Company has recently purchased a five-acre site adjoining its No. 3 plant at Tallmadge, Ohio, for the purpose of further expansion. The company, organized in 1865, now operates three plants for the manufacture of acid-proof chemical stoneware.

PIPE JOINTS

Midwest joints, manufactured by the Midwest Piping & Supply Company, Second and Barry Streets, St. Louis, on which patent is pending, are designed and constructed so that no gaskets nor field welding are required. The joint contact is made between specially machined convex and concave spherical surfaces.

A tight joint and flange adjustment is allowed to be made with proper pipe alignment while there may be deflections in the line since the joint is made by contact of spherical surfaces, and faces of laps and the flanges are also spherical.

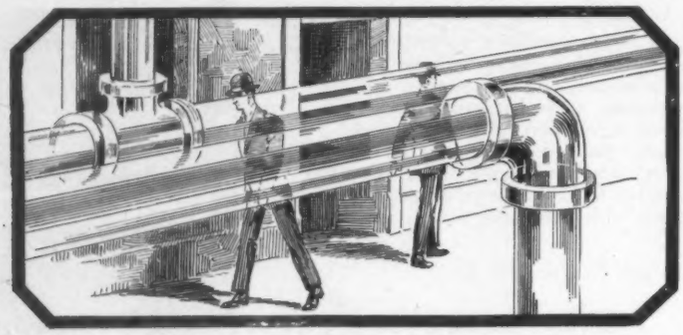


Midwest Joint Between Pipes

Sufficient clearance between the pipe the contact surfaces between back and flanges is had to allow pipe line deflections of approximately five degrees. The new ball and socket joint action allows adjustment to expansion and contraction without strain. No threads are used on the joints.

The thin section of the female end parallel to the pipe wall is made heavier than the pipe to give the joint laps greater resistance.

Midwest Piping & Supply Company has recently issued a folder describing and illustrating its line of joints, and copies may be secured by writing the company at the above address.



If Your Pipes were Glass—

—then you could *see* the foreign matter constantly passing through them. And seeing it, you would take immediate action to prevent it from clogging steam traps, valves, regulators, etc., by installing the

SARCO
Strainer

The Sarco Strainer is an absolute necessity. It keeps valve seats and other delicate parts free from scale and sediment, eliminating the time loss entailed in cleaning, not to mention the money loss due to shut-downs.

Quickly couples up with any pipe line, in any position. Adapted to steam, water, oil, gas, etc. Cleaned automatically through blow-off valve. Flow of fluid uninterrupted. Simple, practical, low in cost.

Write for booklet S-200 or mail the coupon.

SARCO CO., Inc.

183 Madison Ave. New York, N. Y.

Boston Chicago Detroit Pittsburgh
Buffalo Cleveland Philadelphia St. Louis

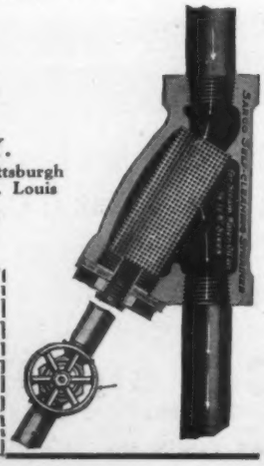
Sarco *(Canada)* Limited
1605 Delorimier Ave., Montreal

SARCO CO., Inc.
183 Madison Ave., New York, N. Y.
Please send copy of Sarco Strainer Booklet S-200.

Name .....

Address .....

Town ..... State .....



Safety Appliances

Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh, has recently issued Bulletin No. 113, describing the F-M Continuous flammable vapor indicator, and Bulletin No. 27, describing the McCaa Oxygen breathing apparatus, half-hour type. Both bulletins are illustrated, especially as to how this equipment is used, and the safety features employed. Copies are available on request.

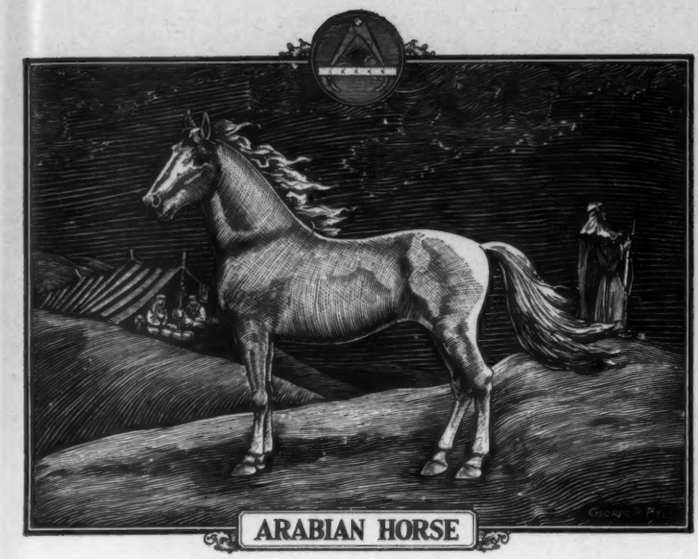
V-C Wick Lube Oil Filter

VINSON-CANTER COMPANY

The Vinson - Canter Company, Wright building, Tulsa, is introducing the V-C Wick Lube Air Filter for the natural gasoline and refining divisions of the petroleum industry. The device is for use on air intake valves of both internal combustion engines and compressors.

Literature, description of the equipment, contains this:

"The principal by which the dust is removed is that of surface contact and



QUALITY

A characteristic of the Arabian Horse and also of the products manufactured by The Garlock Packing Co., Palmyra, N.Y.

ARABIAN horses were originally obtained from the Libyan tribes of Northern Africa. By long and careful mating the superior type has been maintained through many centuries. The breeding and raising of the Arabian horse is closely supervised and controlled by the owners so as to obtain certain desirable qualities such as endurance, strength, intelligence, tractability and fine appearance.

Realizing that quality in commodities, as well as in domestic animals, is secured by years of close supervision of details, The Garlock Packing Company has continually striven in the past quarter of a century to build products whose body structures and treatments are basically right to meet the requirements of an economical and satisfactory packing service.

This fundamental characteristic of Garlock manufacturing processes has merited the descriptive name *Quality Controlled Packings* for their products.

THE PURE OIL CO

The Seal of Uniform Quality

Prompt Service

For Any Petroleum Product, Phone, Wire or Write

THE PURE OIL COMPANY

U. S. A.

Producers, Refiners, Marketers of a complete line of petroleum products

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REFINERIES:

Marcus Hook, Pa.
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Heath, Ohio
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Smith's Bluff, Tex.

For cracking process in oil refineries we furnish Aluminum Armored Asbestos filled Gaskets and Corrugated Armco Iron or Monel Metal Asbestos encased.

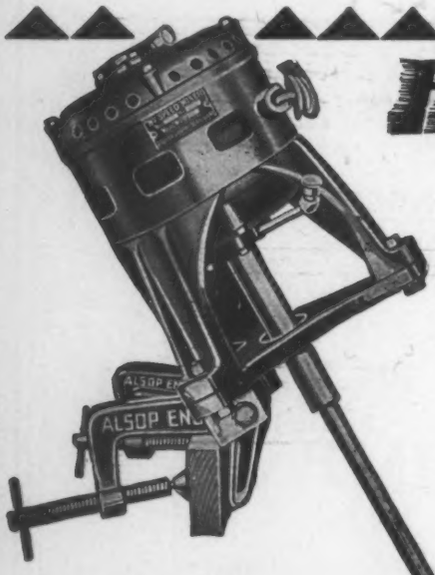
Copper rings 3/16" thick for 4 and 5" O. D. tubing.

Washers or gaskets made of Aluminum, Copper and other Metals.

Write for Prices.

METALLO GASKET CO.

NEW BRUNSWICK, N. J.



Hy-Speed

EXPLOSION-PROOF MIXERS

Hy-Speed Portable Electric Mixers are the most efficient machines manufactured for blending, compounding, mixing or agitating all oils and liquid chemicals.

They clamp to any tank or vat in one minute and produce a more thorough, rapid mix . . . . more economically than by any other process. Capacities from five to 50,000 gallons.

Write for your copy of «The Hy-Speed Age» ..... the Solution of your Mixing Problems.

For mixing

LUBRICATING OILS
LIME AND OIL
FULLER'S EARTH & OIL
ALL LIQUID CHEMICALS

ALSOP ENGINEERING COMPANY
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adhesion to wet surfaces. In passing through the filter air is divided into a number of small streams. The direction of these small ribbons of air is continually changing while they are being scrubbed against surfaces which are kept wet with adhesive oil. Not only the direction but also the size and shape of the streams are changing so that all of the air comes in contact with the wet surfaces. The oil is fed into the filter media by means of wick lubricators located directly above each unit of the filter. The continuous, slow, feeding of adhesive oil over the filter media results in the filter being kept at a high state of efficiency and prevents a drop in efficiency due to drying of the adhesive oil."

PUMP BULLETIN

United Iron Works, 580 Second Street, Oakland, California, has just issued a centrifugal pump bulletin of particular interest to the refinery engineer. The leading feature of the bulletin is a portion of the article "Flow in Pipes," by M. D. Aisenstein, chief engineer of the pump division of the company.

The bulletin gives a complete outline, including illustrations, of the pumps manufactured by the company. A copy is available upon request to the Southwestern Engineering Corporation, 606 South Hill Street, Los Angeles.

CHANGE OF NAME

The National Fire Proofing Company has changed its name to National Fire Proofing Corporation, effective with an announcement of December 5. All of the assets, liabilities and business of the National Fire Proofing Company are sold to the new corporation January 1, 1930. Headquarters is at Pittsburgh. S. F. Heckert is president.

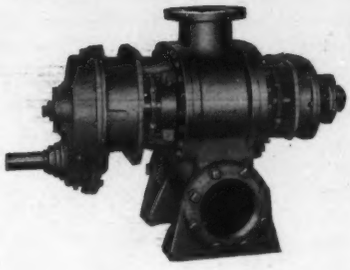
Considerable expansion is planned by the corporation for 1930, including the marketing of four additional specialties.

Tube-Turns, Inc., Louisville, Kentucky, has issued Bulletin No. 104, a 20-page booklet on pipe welding with stock fittings in the process industries. Methods of welding some of the most complicated hook-ups confronting the construction engineer in refineries, natural gasoline plants and chemical plants are shown with photographic illustrations. A copy of this bulletin is available upon request to the home office or any representative of the company.

CAMPBELL REPRESENTATIVES

Campbell Engineering Company, Short Hills, New Jersey, has recently appointed the following representatives, which are the only representatives for that company now: George B. Allen & Company, 327 Exchange National Bank Building, Tulsa, and 405 Texas Building, Dallas; L. E. Pollard, 205 Oliver Building, Pittsburgh, and the Smiley Equipment Company, 202 Carmen Building, Kansas City, Missouri.

Waterous Rotary Pumps



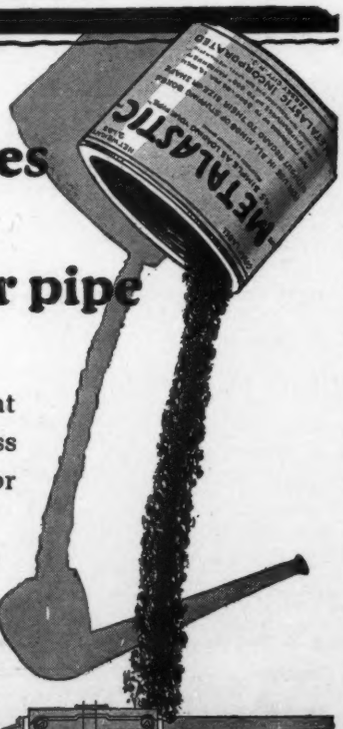
The high efficiencies and dependability of Waterous Rotary Pumps are the result of proper design and liberal proportions. Every detail is carried out in order to produce a high grade and reliable pump.

Waterous Dependable

WATEROUS COMPANY

ST. PAUL, MINNESOTA

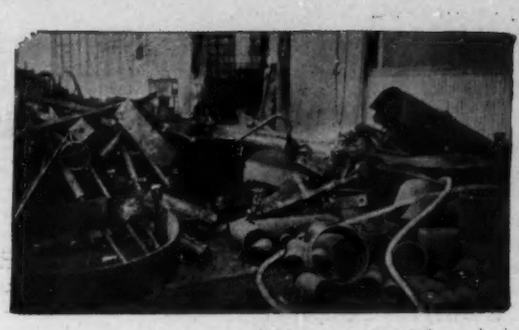
Packing Stuffing Boxes as easy as loading your pipe



Serves in any plant equipment, regardless of service, pressure or temperature.

METALASTIC INCORPORATED
Jersey City, N. J.

METALASTIC
For *All* Stuffing Box Requirements!



Equipment like this costs money

PIPE fittings, fishing tools, valves and other parts, lying about in the salvage yard represented a substantial investment when new. And many of these parts would still be serviceable, would still yield a return, if stripped of accumulated dirt and oil.

You can remove every trace of muck and grease quickly and with little effort the Oakite way. No scrubbing or scraping. A short soak in a solution of an Oakite material, a brief rinse, and parts are clean to the metal.

Our Service Man in your locality can show you how much time and work Oakite cleaning saves. Write and ask to have him call. No obligation of course.

Manufactured only by
OAKITE PRODUCTS, INC., 50B Thames St., NEW YORK, N. Y.

Oakite Service Men, cleaning specialists, are located at

Albany, N. Y., Allentown, Pa., *Atlanta, Altoona, Pa., Baltimore, Battle Creek, Mich., *Boston, Bridgeport, *Brooklyn, N. Y., Buffalo, *Camden, N. J., Charlotte, N. C., Chattanooga, Tenn., *Chicago, *Cincinnati, *Cleveland, *Columbus, O., *Dallas, *Davenport, *Dayton, O., Decatur, Ill., *Denver, Des Moines, *Detroit, Erie, Pa., Fall River, Mass., Flint, Mich., Fresno, Calif., *Grand Rapids, Mich., Harrisburg, Pa., Hartford, *Houston, Texas, *Indianapolis, *Jacksonville, Fla., *Kansas City, Mo., *Los Angeles, Louisville, Ky., Madison, Wis., *Memphis, Tenn., *Milwaukee, *Minneapolis, *Moline, Ill., *Montreal, Newark, N. J., Newburg, N. Y., New Haven, *New York, *Omaha, Neb., Oshkosh, Wis., *Oakland, Cal., *Oklahoma City, Okla., *Philadelphia, Phoenix, Ariz., *Pittsburgh, Pleasantville, N. Y., Portland, Me., *Portland, Ore., Poughkeepsie, N. Y., Providence, Reading, Pa., Richmond, Va., *Rochester, N. Y., Rockford, Ill., *Rock Island, Sacramento, *San Francisco, *Seattle, Springfield, Mass., South Bend, Ind., *St. Louis, *St. Paul, Syracuse, N. Y., *Toledo, *Toronto, Trenton, *Tulsa, Okla., Utica, N. Y., Vancouver, B. C., Wichita, Kan., Williamsport, Pa., Worcester, Mass.

***Stocks of Oakite materials are carried in these cities.**

OAKITE

TRADE MARK REG. U.S. PAT. OFF.

Industrial Cleaning Materials and Methods

WALWORTH ABSORBS WESTCOTT

Walworth Company of Boston, manufacturers of valves, fittings and tools, has purchased the assets of the Westcott Valve Company of East St. Louis, Illinois. The transaction was completed October 1, through an exchange of Walworth stock for the assets of the Westcott Company.

Vice-President Prentiss L. Coonley of the Walworth Company has announced that the Westcott Valve Company would continue the manufacture of valves as a separate entity. The Westcott organization will be maintained intact.

The Westcott line consists wholly of oil field equipment, and includes steel, iron body and semi-steel gate valves adapted to oil field use.

The Westcott plant at East St. Louis is equipped for the manufacture of large pipe line valves. It operates an iron foundry and a modern finishing shop.

A. V. Wadsworth, manager of the Westcott plant, will continue in that capacity.

Paul Reid has recently opened an office at 1017 Second National Bank Building, Houston, where he is representing several manufacturers in the Gulf Coast territory. His connections include the Garrott Brass and Machine Company, Houston; Natural Gas Equipment Company, Los Angeles; Leland Brothers Company, Los Angeles; Lebus Rotary Tool Company, Electra, Texas; Universal Machine Company, Houston; and Weber's Insulation, Inc., East Chicago, Indiana.

Prior to entering business for himself, Reid was connected with Gulf Supply Company, as salesman. He served the Houston Oil Company as purchasing agent until 1927, when he joined the Texas Steel Company at Fort Worth.

ANNOUNCEMENT

Now we are prepared to supply refineries with the Thermix Air Heater to heat air for oil stills.

This is the same heater that is sold by the Babcock & Wilcox Co. to preheat air for boilers. Hundreds of Thermix Air Heaters have been in use for years. They are saving vast sums by utilizing *waste* heat.

THERMIX AIR HEATER for OIL STILLS

consists of removable flat steel sheets direct from the plate mill, without any welding or riveting whatever. The sheets are made into gas and air sections (guaranteed against any leakage up to 20″ wg. differential pressure) by a special patented arrangement.

For temperatures above 1000° F. the Thermix is equipped with a chrome steel section, constructed of removable, reversible welded units.

Mail the coupon, or write for our interesting catalog T-18.

PRAT-DANIEL CORP.
183 Madison Avenue,
New York, N. Y.

The Babcock & Wilcox Co.,
New York

Exclusive Sales Representatives for
Thermix Heaters to Preheat Air for Boilers

Manufactured and Sold in Canada by
Riley Engineering & Supply Co., Ltd., Toronto

Manufacturers of Thermix Air Heaters and Thermix Stacks

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Without obligation on our part, please send the following:
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Elliott Bulletins

The Elliott Company, Jeannette, Pennsylvania, has just issued three new bulletins, which will be sent to interested persons upon request. Bulletin L-2, describes in four pages the Elliott 3500 r.p.m. induction motors, a line of high-speed high-power factor induction motors offering several new designs. Bulletin L-3 in four pages describes and illustrates the special type of synchronous motor, the Elliott Type A-1 for compressor drive with added fly wheel effect furnished. Bulletin A-4, in 24 pages, describes the Elliott strainers, in several types, as twin strainers, motor-operated strainers, twin oil strainers, single and intake strainers.

Arrangements have recently been made whereby the Babcock & Wilcox Company gets exclusive sale of Thermix air heaters to preheat air for boilers. The Prat-Daniel Corporation will continue to furnish Thermix air heaters for other applications, according to the announcement.

Bristol Catalog

The Bristol Company, Waterbury, Connecticut, has recently issued Catalog No. 2100 on the subject of Bristol's recording psychrometers, and announces that copies will be mailed upon request. The new product is fully described and illustrated in this catalog.

Solvent Sales Organization

Industrial Naphtha and Solvent Company has been organized in Texas with headquarters in Wichita Falls, where offices are maintained at 516 Bob Waggoner Building. The incorporators are W. C. Duncan, president and sales manager; J. C. Rudy and C. W. Scharatt, all of Wichita Falls. The company will specialize in the sale of naphthas and solvents and commercial chemicals.

J. E. Rouse, who has been superintendent of plant No. 3 for the Midwest Refining Company, Inc., at Casper, Wyoming, has been appointed general superintendent of all three plants in that city. He was succeeded as superintendent of plant No. 3 by R. E. Beard, who was a foreman.

C. G. Meyer, representative of the Crane Company, Chicago, spent the first week in December in the Gulf Coast and Southwest Texas.

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ABSTRACTS OF TECHNICAL LITERATURE

Of Particular Interest to the Plant Operator

By H. L. KAUFFMAN

Bumping of Hot Crude Oil Products Containing Water. A. O. Yurkov. (*Neftyanoe Khozyaistvo*, 16, 3262-3, (1929); *C. A., Vol.* 23, *No.* 19, *p.* 4807.)

The bumping of hot crude oil products in the presence of water is due to the superheating of the water phase below the oil. This superheating depends upon the weight of the oil column and its viscosity. It is also influenced by weak soap solutions. Superheating can be avoided by the creation of an evaporating surface inside the water itself; for example, by introducing porous material that occludes air. A theoretical explanation of this phenomenon is given in the original article.

Cracking

Cracking-coil Thermal Calculations. S. Obryadchikov. (*Neftyanoe Khozyaistvo* 16, 357-61 (1929); *C. A., Vol.* 23, *No.* 19, *p.* 4808.)

By using Sakhanov (Sachanen) and Tilich'ev's data "Cracking in the Liquid Phase," Moscow, 1928 (Russian), the amount of heat required to crack a given oil at a given temperature for a predetermined yield of gasoline is calculated. The amount of heat absorbed by the cracking reaction per *m. of* tube (velocity 1 m./sec.) is expressed by the equation:

$$Q_{reac.} = \frac{500\ G_2\ P_{400}\ 2^{\frac{t\ 400}{10}}}{100},$$

where G_2 is the weight of stock sent through the tubes; P_{400}, percentage of cracked gasoline formed at 400°C. during the passage through one meter of tube; *t*, the temperature of the liquid in this section of the tube. $Q_{reac.}$ is plotted against P_{400} as a function of the velocity of the flow of the liquid in the tubes in meters per second for one square centimeter of the useful tube surface. The mean temperature, etc., difference can be determined by using these data and the method of sub-dividing the temperature curve into 10° sections. In a typical example, the formation of 2.6 per cent. gasoline on stock subjected to cracking is calculated. When the oil is heated above 400-420°C. a much greater quantity of heat is required to effect cracking than er heating temperatures require larger in the ordinary stills. This is attained by the increase of the heating surface. Low-tubes; higher temperatures require smaller tubes.

New Cracking Equipment. Anon. (*Azerbeidyanskoe Neftyanoe Khozyaistvo* 1929, *No.* 5, 101; *C. A., Vol.* 23, *No.* 19, 1929, *p.* 4808.)

The Vickers Company intends to improve its cracking equipment in Grozny and Baku by the following modification: The fuel oil is moderately heated in the first coil whereby the gas-oil fraction and a part of the lubricating oil cut are distilled. A second coil, which is the cracking coil, cracks the bottoms together with the gas-oil fraction, which was also sent through the rectification column for the cracked gasoline. This is the first installation of its kind which is to be built by Vickers.

Distillation

Distillation. B. E. Vlasenko. (*Neftyanoe Khozyaistvo* 16, 212-5, (1929); *C. A., Vol.* 23, *No.* 18, *p.* 4561.)

The efficiency of stills can be increased 25 to 30 per cent by injecting into the vapor line a certain amount of water or of an oil fraction identical in boiling point with the vapors passing through the vapor line. A part of the vapors is condensed and a vacuum is thus created which increases the capacity of the still. The remaining vapors are condensed in the condensers.

Flashing. I. Klingerman and N. Bogoslovskii. (*Azerbeidyanskoe Neftyanskoe Khozaistvo* 1929, *No.* 2, 70-6; *C. A., Vol.* 23, *No.* 18, *p.* 4562.)

In a gasoline stripping plant the preheated crude oil is sent through a pipe still into an evaporator placed in the flue and heated by flue gases. The hot oil is spread over two bell-shaped baffles in succession in this evaporator. The oil collected on the bottom is heated by a steam coil and the vapors thus produced carry the vapors produced on the baffles to the upper part of the evaporator, filled with Raschig rings. The vapors pass through a tower where they are sprayed with hot naphtha and through a second tower sprayed with cold water. The uncondensed vapors pass finally through two condensers of the usual type.

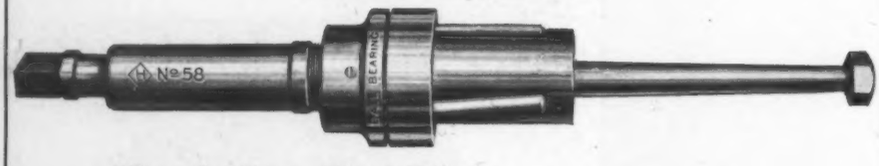
Vacuum Distillation. S. A. Vishetravskii. (*Neftyanoe Khozaistvo* 14, 769-71, 1928; *C. A., Vol.* 23, *No.* 18, *p.* 4333.)

When fuel oil is distilled in vacuum stills, some cracking is likely to occur, principally in the first and last stills. The overheating of the oil can be prevented by the use of more steam, which acts as a carrier, and by using the oil in finely divided form, which can be effected by atomizing it into the still.

Fractionation

Rectification Columns and Fillers. S. Vishetravskii. (*Azerbeidyanskoe Neft-*

Heavy Duty Expanders for Still Tubes



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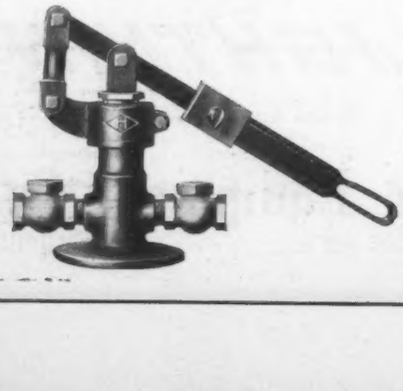

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yanoe Khozyaistvo 1929, *No.* 3, 56-66; *C. A., Vol.* 23, *No.* 18, *p.* 4561.)

A critical review of various American and Russian rectification columns is given. Comparative runs are described and conclusions drawn.

Improving the Performance of Rectifying Columns and Evaporators. E. Mishkin. (*Azerbeidyanskoe Neftyanoe Khozyaistvo* 1929, *No.* 3, 72-4; *C. A., Vol.* 23, *No.* 18, *p.* 4561.)

Rectifying columns can be improved by installing a vertical cylinder in the lower part of the column, immersed in the condensate. Steam injected at the bottom of the cylinder, which is open at both ends, sets the condensate in circulation and carries off gasoline vapors held by the liquid. In another improvement, the condensate discharge pipe is attached at the upper level of the condensate and is bent downwardly in U-shape, insuring constant level. The condensate collected in the bend prevents vapors and gases from escaping from the rectifying column with the condensate.

Chemical Treatment

Chemical Reactions Involved in the Refining of Petroleum. Birch and Norris. (*Fuel Conference, Oct.,* 1928. *London. J. I. P. T., Dec.,* 1928, *p.* 349A.)

The paper deals with the reduction of sulphur content of the lighter fractions of crude oil, and gives details of the reactions which occur during the use of various reagents. The soda-washing of light distillates removes hydrogen sulphide completely and mercaptans partly. The readiness with which hydrogen sulphide undergoes oxidation to free sulphur necessitates its removel at the earliest opportunity. Free sulphur reacts with sodium sulphide to give polysulphides which oxidize mercaptans to disulphides, the latter passing back into the oil. Sodium plumbite solution is used after soda-washing to sweeten an oil which contains mercaptans, these being converted to lead mercaptides which are partly oil soluble and incompletely precipitated. Addition of free sulphur completes the treatment, lead mercaptides being converted into insoluble lead sulphide and oil-soluble disulphides. Aqueous alkaline hypochlorite solution oxidizes organic sulphides to sulphones, disulphides to sulphonic acids and mercaptans first to disulphides and then to sulphonic acids. Excess of alkali stabilizes the hypochlorite solution and retards the oxidation of sulphur compounds. Sulphuric acid has a general solvent action on sulphur compounds dissolved in a petroleum distillate. Mercaptans are oxidized to disulphides, which are dissolved in the acid. Sulphonation of aromatics occurs, and basic substances are removed as salts. Sulphuric acid acts as a polymerizing agent for the more reactive constituents of cracked distillates, but its action is greatly dependent on the concentration and temperature at which it is used. Aqueous cuprammonium sulphate is said to remove mercaptans, disulphides, acetylenes and diolefines. Aromatic or unsaturated hydrocarbons are much more soluble than paraffins in

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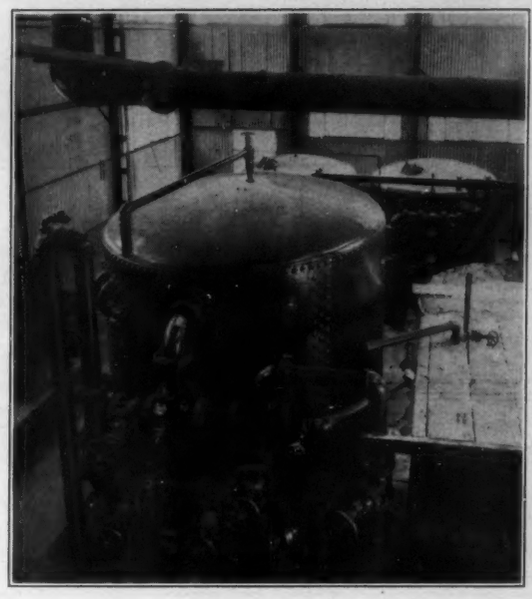

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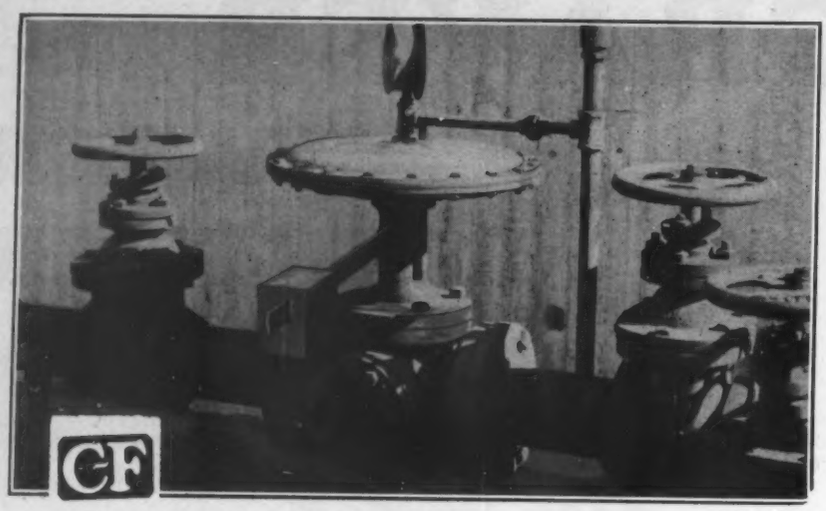

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liquid sulphur dioxide, this forming the basis of Edeleanu's process. The extract is a valuable source of antidetonating fuel. Owing to a preferential solubility a partial desulphurization is also effected. Anhydrous aluminum or zinc chlorides act as energetic polymerizing agents for unsaturated hydrocarbons even at ordinary temperatures, whilst at high temperatures they act as desulphurizing agents. Roasted bauxite is a desulphurizing and decolorizing agent for kerosene. The action is one of adsorption, but oxidation of sulphur compounds by adsorbed oxygen also plays a part. The action of silica gel is probably similar to that of bauxite. Fuller's earth and floridin are used as filtration media to remove color from kerosene, and are also employed as polymerizing agents for treating cracked distillates in the vapor phase.

Filtration

Action of Fullers Earth on Coloring Matter in Oils. Haseman. (J. Phys. Chem. Oct., 1929, *pp.* 1514-27; *Libr. Bull. U. O. P. Co., Vol.* 4, *No.* 42.)

Deposits of fullers earth were originally beds of calcareous earth containing aluminum hydroxide and colloidal pectoid silica, as well as marcasite and pyrite. The best bleaching fullers earth is found in swampy regions and near the level of the underground water. Where the deposit runs back into high hard ground the earth often becomes useless for bleaching because the ground water does not get down to it. The azo-humic acids in ground waters dissolve sand and form azo-silico-humic acids, from which colloidal silica is deposited in the clays. Sulphuric acid is formed from the marcasite and pyrite. This dissolves out a portion of the aluminum, and the earth is then ready for effective bleaching action.

Bentonite, halloysite, indianaite, etc., can be activated by treating with sulphuric acid and boiling. For bentonite, boiling with one-third of its weight of commercial sulphuric acid diluted with two-thirds of its weight of water for about three hours is sufficient to remove enough aluminum for activation. Halloysite contains three times as much aluminum as bentonite and hence requires more than its weight of sulphuric acid to activate. Indianaite is said to be kaolin, but it is not. It is made up of aluminum hydroxid and di-silicic acid. Five or six per cent. of aluminum left in it in some way facilitates bleaching neutral oils by aiding the di-silicic acid in freeing hydrogen and hydroxyl ions for that purpose; but sulpho-acid colors are best removed from oils by an earth containing little or no aluminum. A good fullers earth usually contains about five times as much silicon as aluminum. Part of the silicon is present as aluminum silicate and part as silicon dioxide. But the active silicon is that in the form of di-silic acid.

Experimental evidence is given to show that some of the red and yellow colors in oil are due to the action of the sulphuric acid and caustic soda used in treat-

ing upon azo-humic acids present. It is the relative acidity of fullers earth that determines its activity as a bleaching agent. The earth has the power to retain hydroxyl and liberate hydrogen ions in distilled water, while the water is in contact with it. The normal sodium hydroxide necessary to neutralize the relative acidity of a given weight of fullers earth is found to be exactly equivalent to the normal hydrochloric acid required to neutralize the ammonium hydroxide liberated when a solution of azo-humate or sap brown is acted upon by the same weight of earth. Activated bentonite, halloysite, indianaite, etc., are heavier and less porous than fullers earth, but will bleach twice as much oil because their relative acidity is twice as high. Silica gel has apparently no porosity, yet when it contains a small percentage of aluminum hydroxide it will bleach more lubricating oil than fullers earth. The pores in fullers earth may be partially plugged up with kaolin, or azo-humic acid to the amount of three per cent. may be deposited in the pores and on the earth by using it to bleach sap brown; if the earth is washed free of alkali and carefully dried it will bleach lubricating oil as well as before; and the plugged up earth will retain less oil than the original.

The important thing in revivifying an earth is to remove the free alkali. Temperatures of over 1200°F. are injurious to bleaching power.

Recovery of Paraffin Wax Absorbed by Fullers Earth. L. Selskii. (Azerbeidyanskoe Neftyanoe Khozyaistvo 1929, *No.* 3, 84-5; *C. A., Vol.* 23, *No.* 18, *p.* 4561.)

Fullers earth containing paraffin wax from treating was freed from paraffin by extracting three times with a naphtha (boiling 90-130°C.) at a temperature of 70-75°C. After heating to redness the earth recovered its original absorption power. The paraffin separated was of good commercial quality and had a melting point of 52.5-53°C. A yield of about 70 per cent., calculated on the waste product, was attained after evaporating the naphtha. A hot water extraction of paraffin was a failure. Emulsions formed as the result of the emulsifying action of the fine suspended fullers earth.

Wax Removal

Exploitation of the Grozney Paraffin Wax Plant. A. Ablovatzkii. (Neftyanoe Khozyaistvo 16, 530-43 (1929); *C. A., Vol.* 23, *No.* 19, *p.* 4813.)

The process of obtaining paraffin wax from Grozny fuel oil comprises the following operations: (1) Distillation of fuel oil; (2) Re-distillation of cuts containing paraffin wax; (3) Settling of the distillate; (4) Refrigeration; (5) Crystallization; (6) Filtration; (7) Repeated pressing of slack wax; (8) Treatment of slack wax; (9) Sweating; (10) Bleaching; and (11) Packing. The fuel oil containing paraffin wax is steam distilled in a battery of 14 shell stills, each still having four dephlegmators. The first six stills deliver cuts below 0.780 specific gravity, which are combined and do not need redistillation. Cuts from the second part of the battery must be re-distilled,

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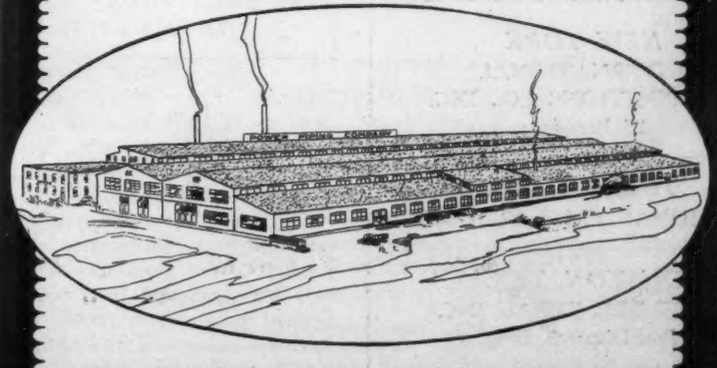

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leaving a petrolatum-like residue.A wax of very fine crystalline structure or of colloidal character is obtained from the machine oil fraction, which is very difficult to handle. Up to 44 per cent. of paraffin distillate was recovered from the fuel oil and 21.82 per cent. of gas and spindle oil fractions was lost in the recovery of the paraffin wax as the result of faulty equipment. This can be eliminated by the use of pipe stills now in the process of construction and of better fractionating equipment. Gas oil containing paraffin from other stills was added to the fuel oil to improve the paraffin yield. The paraffin distillate should be free from water or emulsifying agents. The crystalization temperature is kept within minues 2 degrees to plus 2 degrees. A pressure of 32 atmospheres produces plates of a higher wax content than lower pressures. The temperature to be used during the process depends on the character of the slack wax. Thin cakes are higher in wax than thick ones, the latter being as a rule obtained through less compression. Various lubricating oil fractions could be separated from repeatedly pressed slack wax. Impurities contained in slack wax are removed either through treatment with sulphuric acid (up to 4-5 per cent.) at 70-75°C., followed by neutralization and washing, or by treatment with live steam, the sludge being withdrawn from the bottom. A final treatment with fuming sulphuric acid, followed by neutralization and fullers earth treatment, produces a good commercial wax, which is shipped in plates or in shavings packed in barrels.

OF PARTICULAR INTEREST TO THE ENGINEER

Fuel Oil in the Petroleum Industry. F. Schwartz. (*Mon. petrole roumain* 29, 361-7 1929; *C. A., Vol.* 23, *No.* 17, *p.* 4332.)

Schwartz proposes a steam-boiler plant producing steam at about 8 atmospheres pressure to drive a turbine, the steam entering at full boiler pressure and leaving at 2.5 atmospheres. The turbine operates the electric generators and the exhaust steam from the turbine is used for heating and processing. The steam necessary for this system is only 60 per cent of that required for ordinary steam-driven pumps and the cost of the system, including operation, etc., is 64 per cent of the present steam system and 75.5 per cent of the Diessel engine system.

OF PARTICULAR INTEREST TO THE CHEMIST

Testing and Analyses

Device for Carbon and Hydrogen Analysis of Volatile, Explosive and Easily Carbonizable Organic Liquids. Sevag. (*Ind. and Eng. Chem., Anal, Ed., Jan.* 15, 1929, *p.* 16.)

The device for use in combustion analysis of organic compounds consists of a straight Pyrex glass tube 8.5 cm. long, 6 to 7 mm. i. d. and 10-12 mm. o. d., with ground glass or red rubber stoppers, and having a portion of its length packed with kieselguhr, held in place by plugs of as-

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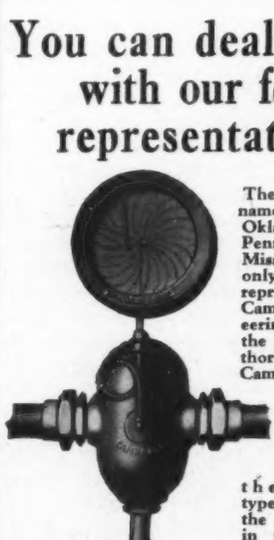

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L. E. Pollard, 205 Oliver Bldg., Pittsburgh, Pa.

Smiley Equipment Co., 202 Carmen Bldg., Kansas City, Mo.

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bestos. The sample for analysis is dropped into the kieselguhr after removing one of the plugs, the latter is replaced after weighing, and with both stoppers out the tube is placed in the part of the combustion tube which is usually occupied by the porcelain boat. Ignition is started gradually as usual, and the effect of the kieselguhr is to keep combustion gradual and smooth throughout. The following figures were obtained for benzene:

Carbon

Found	Calculated
p. ct.	p. ct.
91.97	92.30
92.06	

Hydrogen

Found	Calculated
p. ct.	p. ct.
7.73	7.69
7.88	

Dennstedt (Z. angew. Chem. 18, 1134 (1905) used kieselguhr to analyze petroleum, lubricating, and mineral oils.

Apparatus and Method for the Separation, Identification and Determination of the Chemical Constituents of Petroleum. Washburn, Bruun and Hicks. (Bur. Stds. J. Research, March, 1929, *pp.* 467-488.)

The Bureau of Standards, co-operating with the American Petroleum Institute, is working out adequate methods for separating petroleum into its chemical components. For this part of the work the heavier fractions of a petroleum from an Oklahoma field were used, beginning with the gas oil. Vacuum distillation was not resorted to. Distillation was conducted by holding the oil in the still pot at a constant temperature, below cracking, and forcing dry pure CO_2 through it in streams of fine bubbles. A rectifying column of 20 plates had a separate heating coil for each plate so that complete control was possible, and a temperature gradiant of 70°C. (158°F.) between bottom and top plate was maintained. The oil was distilled to 350°C. (662°F.) in 9 fractions. From some tests made as to the influence of the inert gas chosen upon the amount of cracking in the oil, estimated from the iodine number, it was clear that as between hydrogen, nitrogen, and carbon dioxide there was little difference. When heating to 370°C. (698°F.) continued for 20 hours the increase in iodine number was less than ⅛ of that produced in contact with air by boiling for 20 hours with return condenser.

For further fractionating the fractions obtained as above, a series of all-glass vacuum stills of diminishing size were provided. Heating was by a bath of nickel shot electrically heated. At the time of writing the article over 600 fractions had been separated out of the original gas-oil fraction. Molecular stills were necessary for the distillation of the higher melting paraffin waxes. Such stills are characterized by very high vacuum, large and clean vaporizing surface, short distance from vaporizing surface to condenser, and sufficient temperature difference between vaporizing and condensing surface. Several forms of molecular still are shown. By an equa-

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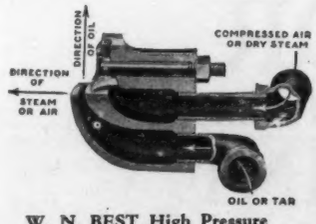

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tion given by Langmuir the amount of a given chemical substance distilling over in unit time can be calculated from the molecular weight, the vaporizing surface, the temperature absolute, the vapor pressure at that temperature, and the gas constant. The temperature necessary for condensation can also be calculated from the temperature absolute of the vaporizing surface, the ratio of the vapor pressure at this temperature to the vapor pressure desired at the condenser temperature, the normal boiling point, absolute, and a constant for the substance given by I. C. T. Vol. III, p. 246. If the normal boiling point of the compound is not known, the difference between vaporizing surface and condenser surface temperature may be taken to be not less than 60°.

Crystallization and the equilibrium melting point method were applied very successfully to fractionation. No petroleum fraction was found which could not be crystallized readily. A metal-to-glass or glass-to-glass combustion apparatus gave accurate results and with the aid of a molecular weight determination made it possible to determine the empirical formula of any hydrocarbon up to C_{100}.

Results of Research and Investigational Work

The Gumming of Lubricating Oils. Seton. (*Chem. and Ind., Jan.* 25, 1929, *p.* 81. *Libr. Bull., U. O. P. Co., Vol.* 4, *No.* 13.)

Lubricating oils may thicken in use, either from the presence of carbonaceous matter or from emulsions formed when steam is present, or as the result of the action of small quantities of soap-like substances formed as addition products between metal particles worn off by attricion and resinous compounds in the oil. What is known as "gumming," however, is due to asphaltenes, from asphaltic resins, present to some extent in all petroleums but found in German oils from Alsace and Hanover to the extent of 5 or 6 per cent. and in Pennsylvania and Russian oils in only very small amounts. The asphaltenes are insoluble in petroleum ether but soluble in benzene. The resins are removed to some extent by refining, but a dark opaque oil was found to give 1.67 per cent. of the resins when tested by the method of the British Engineering Standards Association.

If an oil is heated (at 400°F.) for a number of hours and samples examined under the microscope from time to time the formation and separation of asphaltenes can be followed. The carbon deposits in an internal combustion engine will contain minute metal particles, which catalyze the asphaltene-forming process. Yet the heating test is a valuable guide. Gill, in 1902, described the following test as an indication of what may be expected of an oil in use. Five grams of the oil is mixed with 11 g. of nitrosulfuric acid and cooled. Brownish spots or brown masses form around the edges of the container and turn red in the course of two hours. The oil may be dissolved in petroleum ether and drawn

off, the acid neutralized with ammonia, and the tarry matter filtered off and weighed.

Oils which are reclaimed by filtering after use will probably be unchanged as to their gumming tendencies by the treatment.

New Manufacturing Methods

Preparing Varnish Asphalt from Emba Lubricating-Oil Acid Sludge. N. M. Karskii and S. V. Kapatzinskii. (*Neftyanoe Khozyaistvo* 16, 548-51 (1929); *C. A., Vol.* 23, *No.* 19, *p.* 4812.)

Up to 60 per cent. of an asphalt suitable for varnish was obtained by blowing a mixture of 2 parts acid sludge from Emba lubricating oil, 1 part of turpentine and 1 part of needle-wood tar at 280-300°C. for 18-20 hours. The turpentine vapors were condensed and the sulphurous acid was absorbed in a tower sprayed with water. The yield of asphalt depends greatly upon the size of the fraction of turpentine boiling close to 180°C.

Utilization of Acid Sludge from Lubricating Oil Bottoms. S. N. Obryadchikov. (*Neftyanoe Khozyaistvo* 16, 80-2 (1929); *C. A., Vol.* 23, *No.* 19, *p.* 4810.)

Fifty per cent. of Grozny lubricating oil acid sludge can be converted into an oil-soluble product suitable for fuel by first separating the sulphuric acid partly from the sludge by settling, neutralizing the remaining acid and the sulphonic acids with lime, and extracting the oil-soluble part with gasoline at 50-80°C. From 17 to 20 per cent. of lime, calculated on the acid sludge, was required. Another method, that is, conversion of acid sludge into a solid pulverizable product, consists in blowing the acid sludge with air for 15 minutes at 185-218°C., whereby a solid and very brittle product with a softening point of 113°C. is obtained. The yield is 73 per cent. This product can be used as a pulverized fuel or it can be added in any proportion to a fuel to be pulverized.

Preparing Petrolatums. N. I. Chernozhukov. (*Neftyanoe Khozyaistvo* 16, 240-1 1929; *C. A., Vol.* 23, *No.* 19, *p.* 4812.)

Low viscosity petrolatums are prepared from distillates by a freezing out of the higher melting point wax, followed by a separation, whereby the low-melting paraffin becomes more concentrated in the distillate. High viscosity petroltaums can be obtained by dissolving paraffin bottoms in naphtha, freezing out high-melting paraffins, separating them and concentrating the lew-melting paraffins by cold. To obtain a medicinal petrolatum, only the high-melting paraffins must be removed, leaving 25 per cent. of paraffin in the petrolatum.

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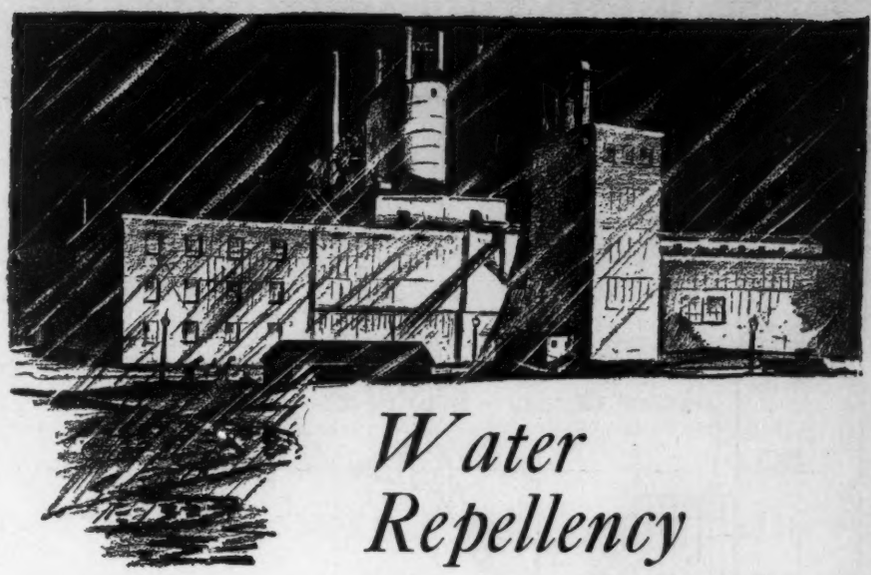

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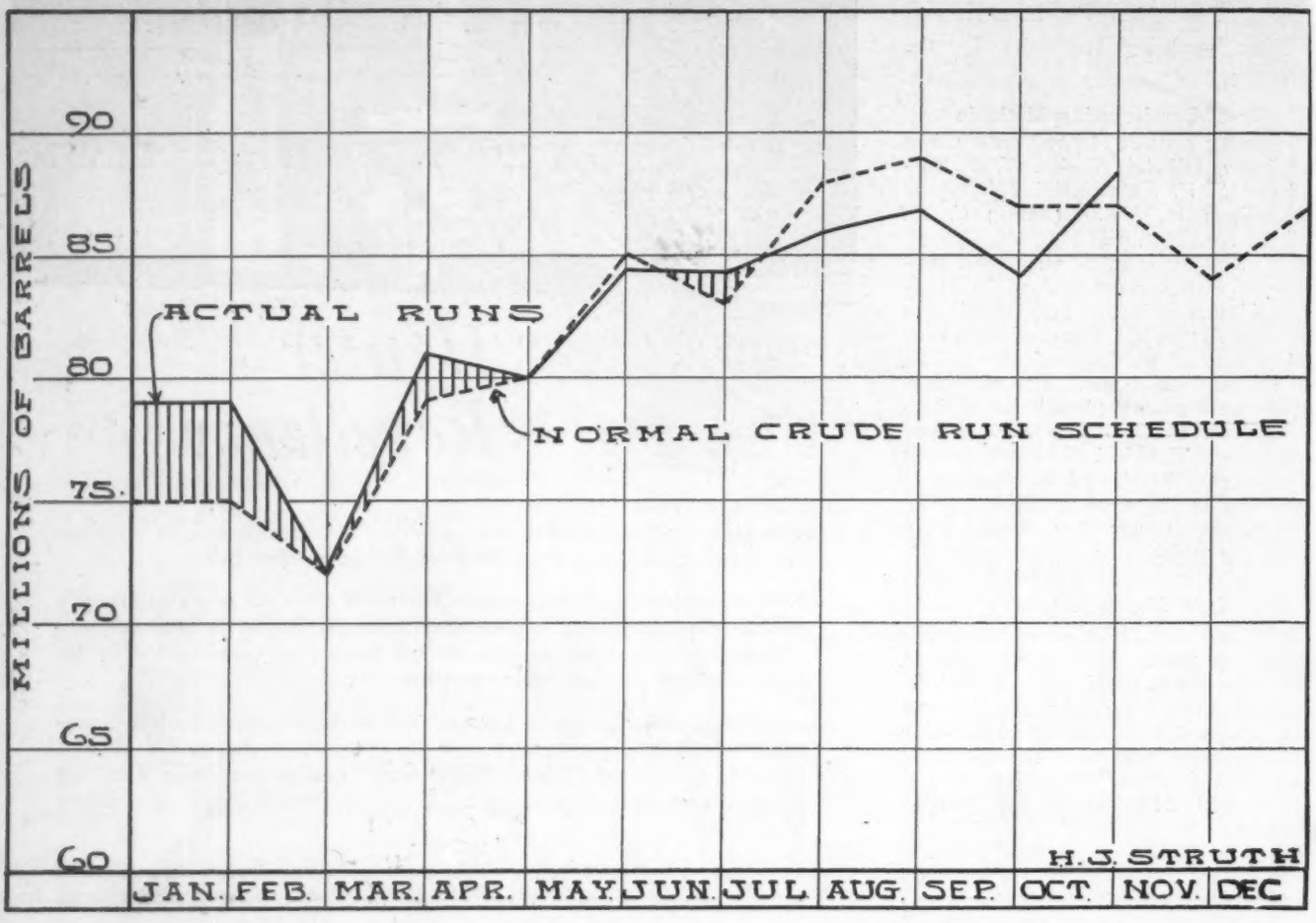

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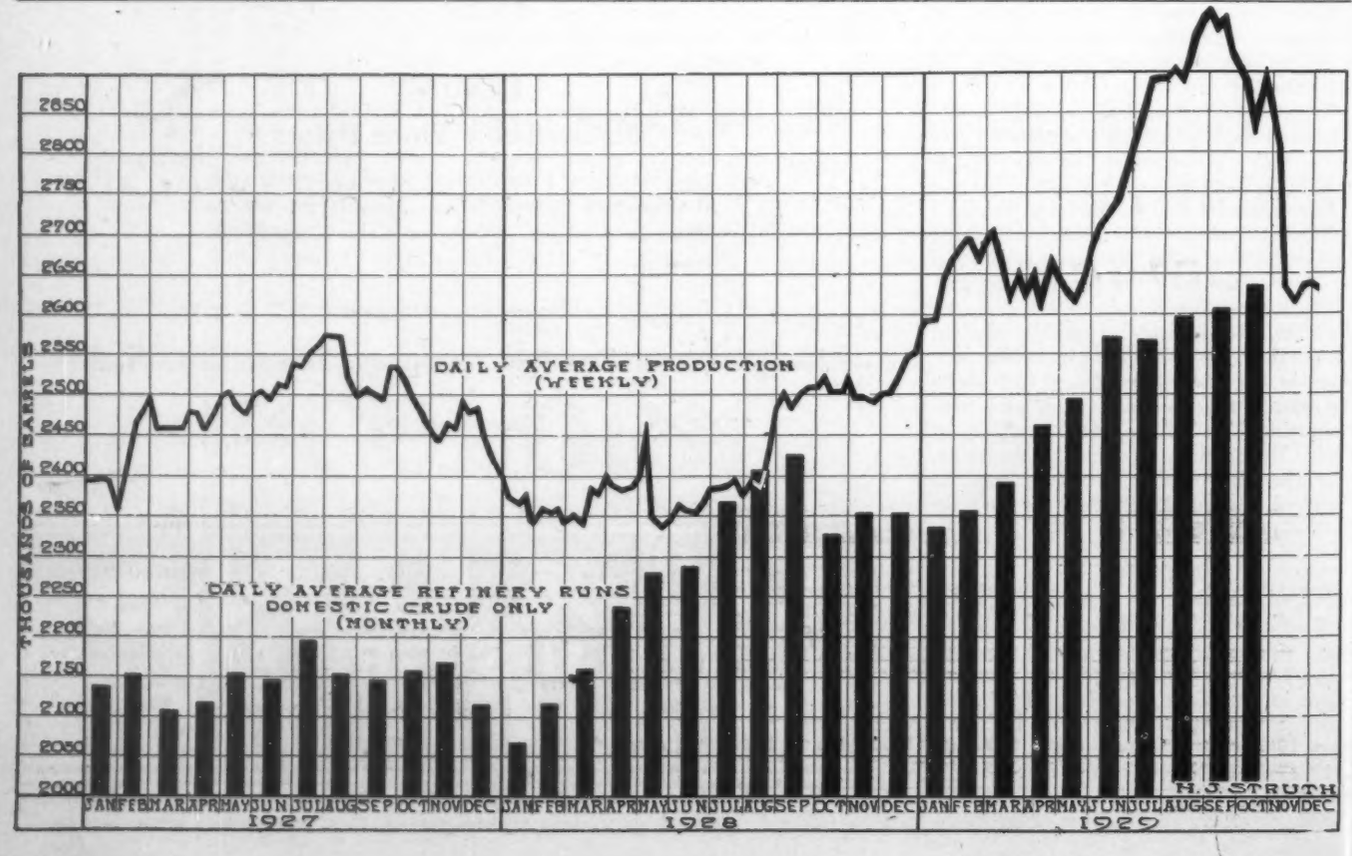

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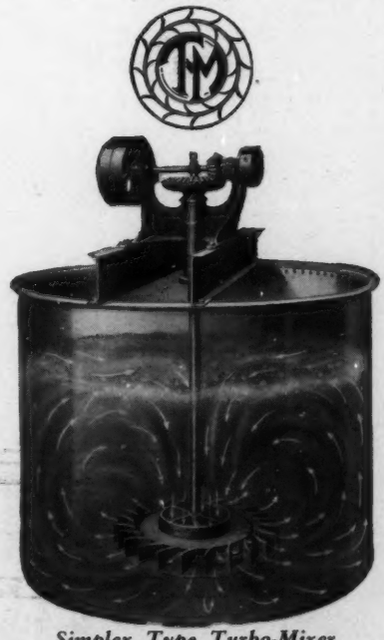

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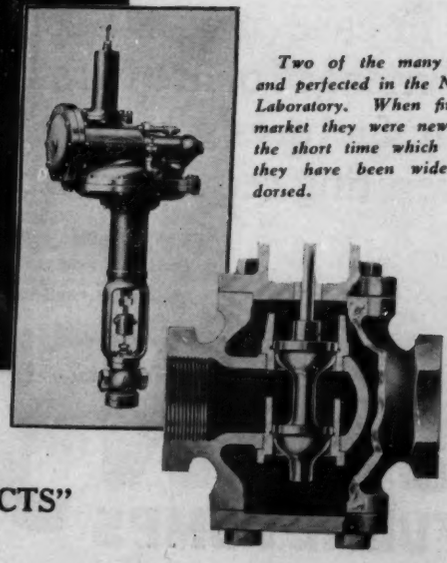

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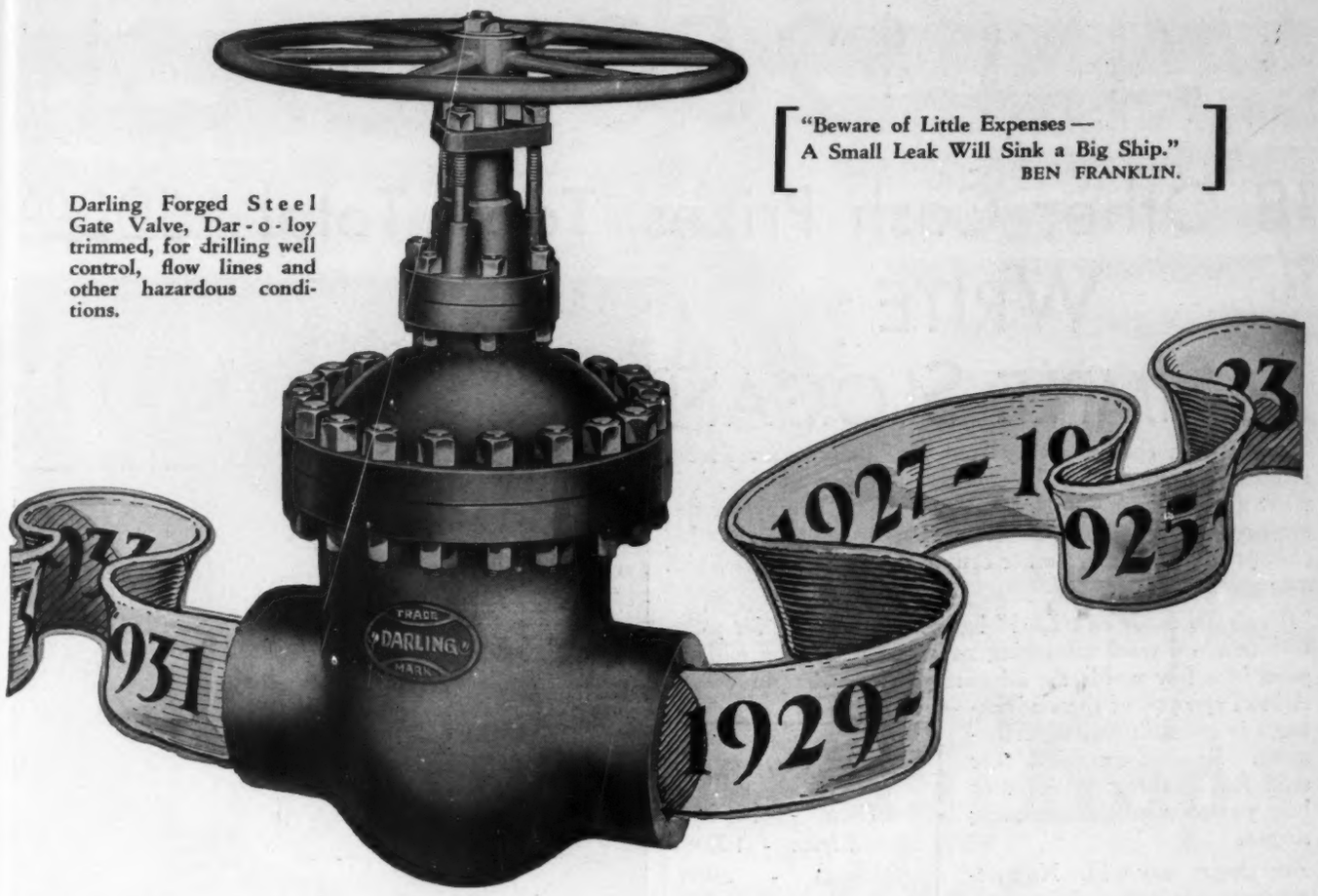

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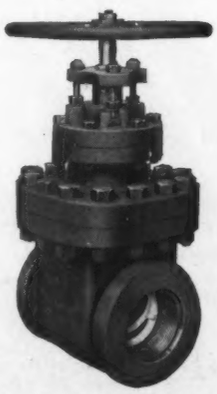

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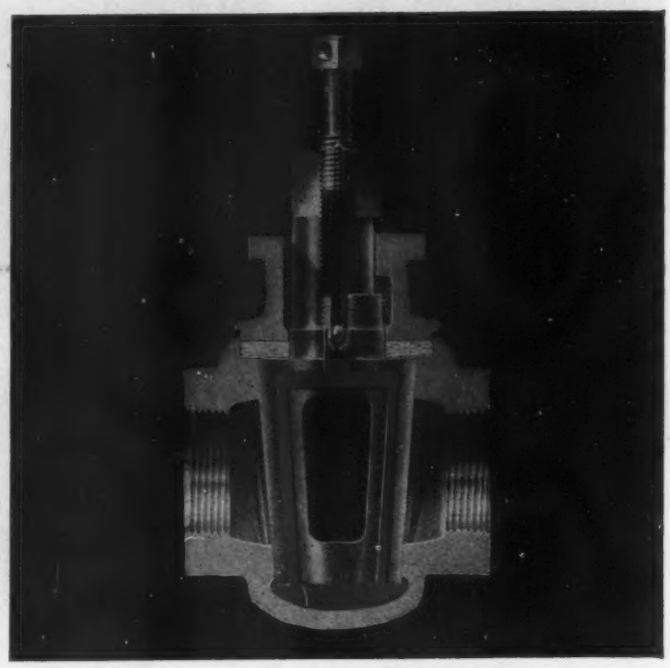

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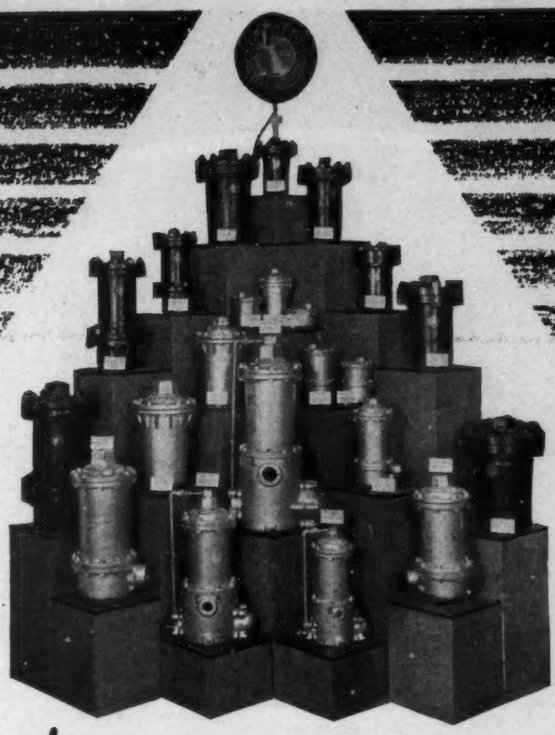
Buenos Aires, Argentine:
General Electric, Soc. Anon., Victoria 618 Esq. Peru.



Each Armstrong Trap is a specialist

Each member of the Armstrong Steam Trap "family group" shown here is a specialist, especially engineered for its job. Armstrong makes no other product. And the line is complete . . . there is a size and style to meet every condensate drainage problem — for pressures up to 900 pounds and temperatures up to 750° F.

Armstrong Traps remove condensate without the loss of live steam, and discharge entrained air and gases. They are easily installed. Most of them are light enough to be supported by the pipe lines in which they are placed.

Want to meet one of the family face-to-face? The coupon below entitles you to use one or more Armstrong Traps for 90 days, without cost or obligation.

ARMSTRONG MACHINE WORKS

352 Maple St., Three Rivers, Mich.

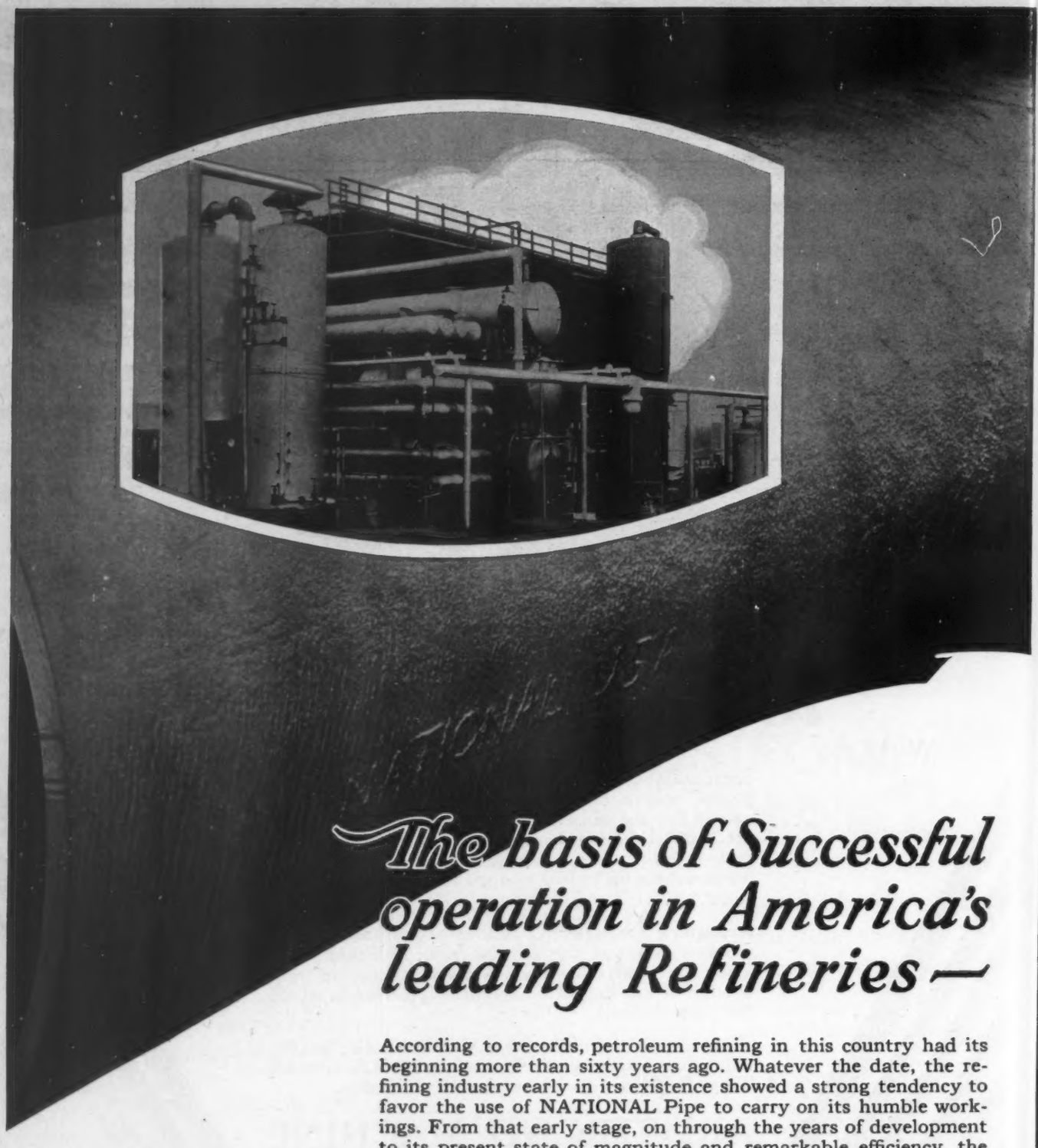
District Representatives in 42 Cities.

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

ARMSTRONG MACHINE WORKS, 352 Maple St., Three Rivers, Mich.
Please ship prepaid an Armstrong Trap for a 90-day test. When the test is completed, the trap will be returned collect.

For service on_____ Steam Pressure (Maximum)_____
Size of Pipe_____
Name_____
Position & Firm_____
Street Address_____
City_____
State_____
☐Send Catalog

R&NGM12-Gray



The basis of Successful operation in America's leading Refineries—

According to records, petroleum refining in this country had its beginning more than sixty years ago. Whatever the date, the refining industry early in its existence showed a strong tendency to favor the use of NATIONAL Pipe to carry on its humble workings. From that early stage, on through the years of development to its present state of magnitude and remarkable efficiency, the industry has continued to place its stamp of approval on the merits of NATIONAL Pipe—approval that has made its use so generous and country-wide as to earn for this product the position of leadership in quality—the recognized basis of successful operation in America's leading refineries.

NATIONAL TUBE COMPANY, Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

NATIONAL PIPE

HOOKER Chemicals

of the Highest Quality

Every product, every process has originated in or passed thru our Research Department. We are justly proud of this painstaking care in development and production. It guarantees you Hooker Chemicals of the Highest Quality.

With plants conveniently located and our policy of carrying ample stocks of materials on hand at all times, we are prepared to make prompt and efficient deliveries to all sections of the country.

Hooker Chemicals

Caustic Soda
Liquid Chlorine
Bleaching Powder
Muriatic Acid
Monochlorbenzene
Paradichlorbenzene
Benzoate of Soda
Benzoic Acid
Benzoyl Chloride
Benzyl Alcohol
Antimony Trichloride
Ferric Chloride
Sulphur Monochloride
Sulphur Dichloride
Sulphuryl Chloride
Salt

HOOKER ELECTROCHEMICAL COMPANY

EASTERN
Plant—Niagara Falls, N. Y.
Sales Office—25 Pine St., New York City

WESTERN
Plant—Tacoma, Washington
Sales Office—Tacoma, Washington

Vogt Boilers
For All Industries

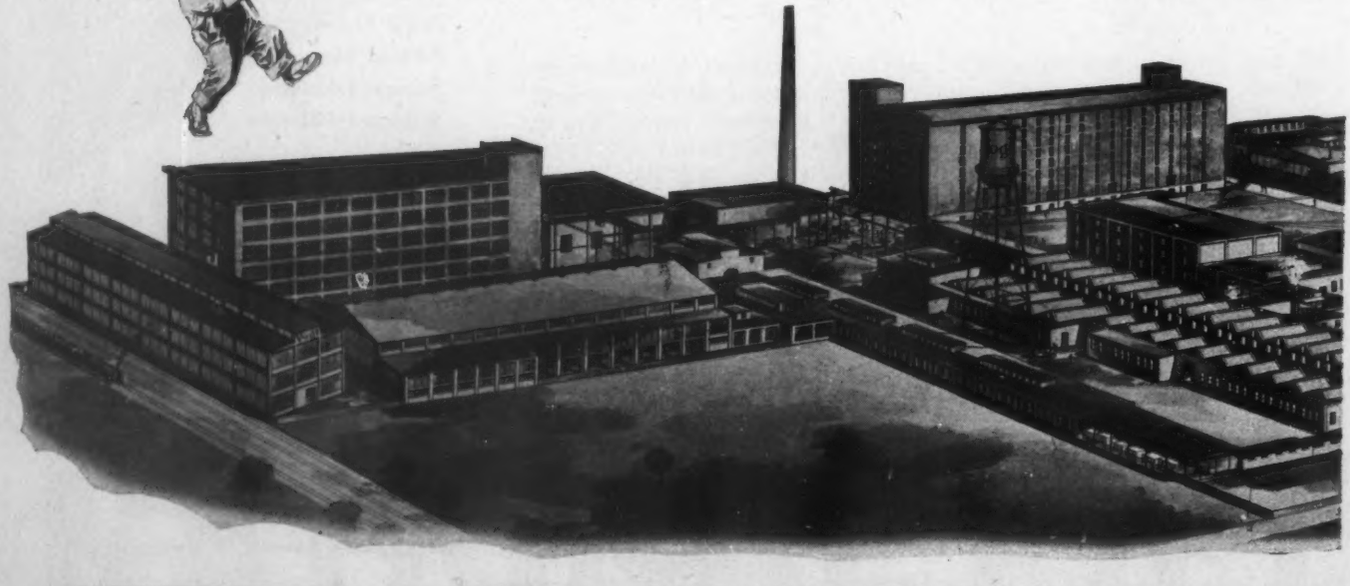
Vogt Boilers are today serving practically every industry requiring steam for power, heating, or process work. They are popular not only because there is a type and size for any condition but because they deliver uninterrupted service continually at the lowest operating expense.

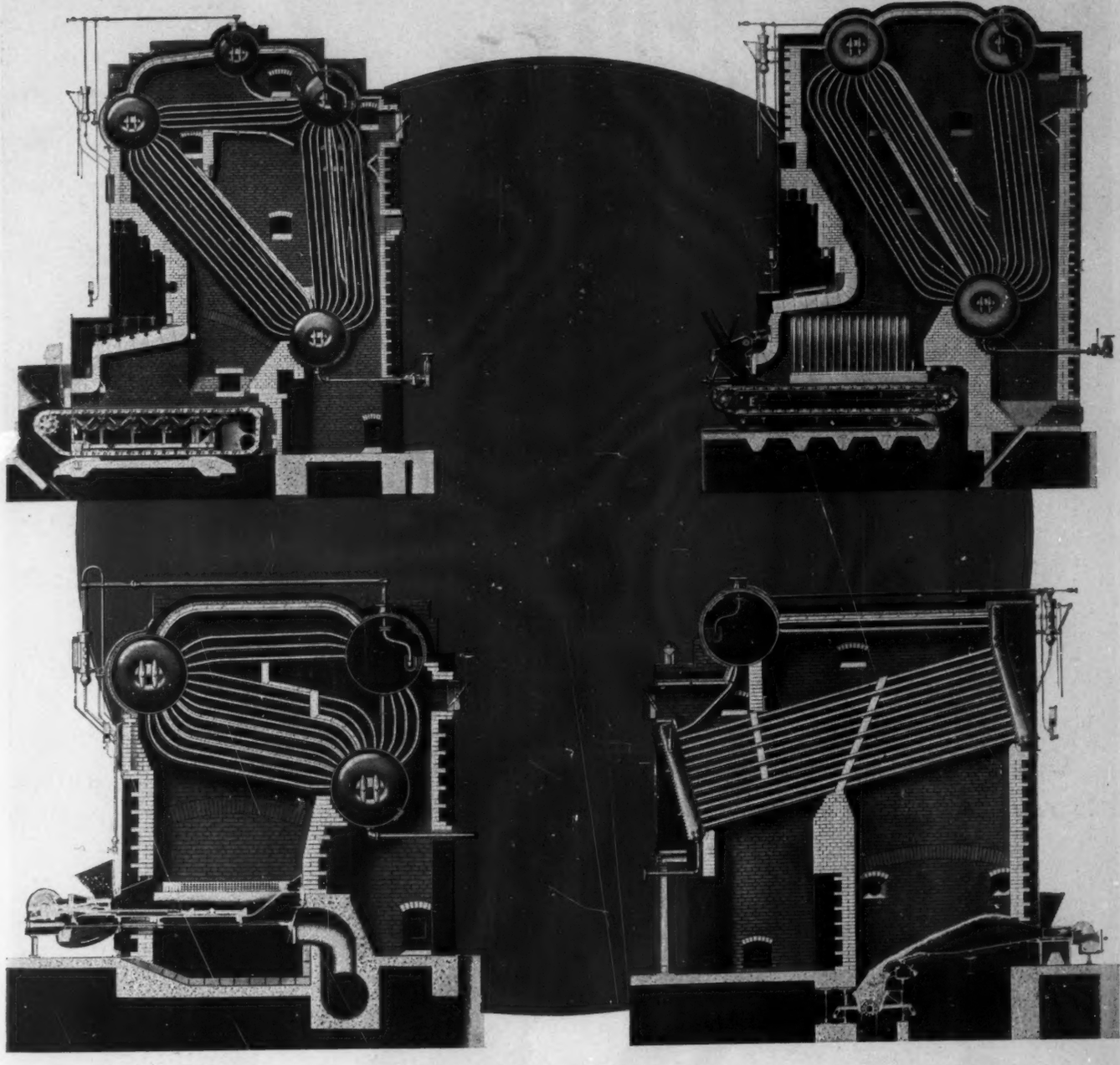
The birdseye below of the Henry Vogt Machine Company plant which covers nineteen acres is a testimony to the facilities and resources of this organization to adequately serve your boiler needs.

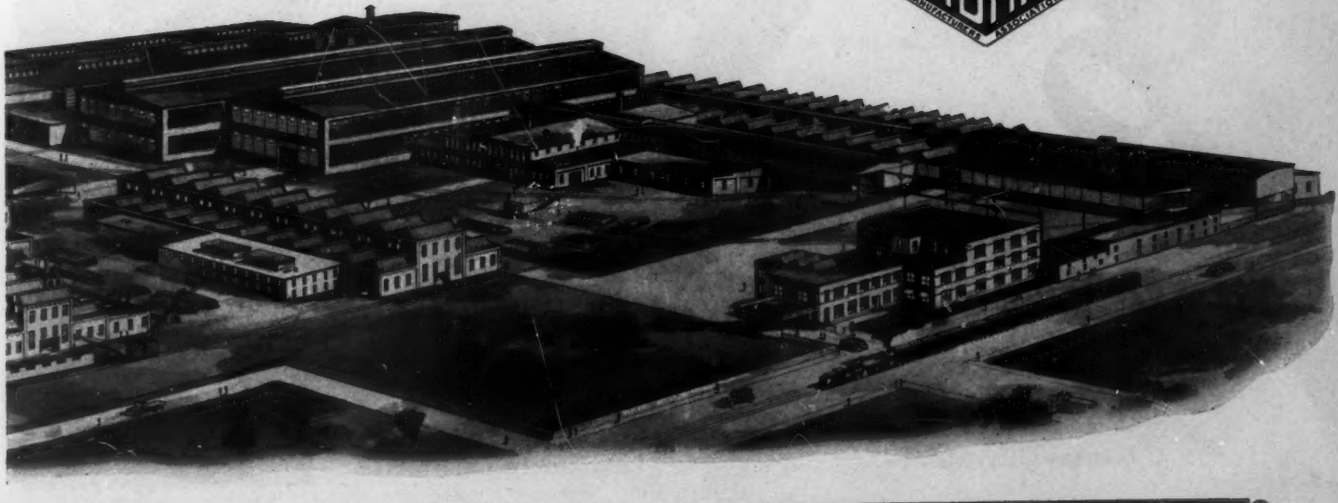
Write for Information

HENRY VOGT MACHINE CO.
(Incorporated)
LOUISVILLE, KY.
New York Chicago Cleveland Dallas Philadelphia

Manufacturers: of OIL REFINERY EQUIPMENT, DROP FORGED STEEL VALVES AND FITTINGS, WATER TUBE AND HORIZONTAL RETURN TUBULAR BOILERS, ICE MAKING AND REFRIGERATING MACHINERY







Only Four Bolts to Tighten

SECO Return Bends are locked to the tubes by simply tightening four bolts. They can, therefore, be installed for a fraction of the cost of other fittings. The skilled labor, the time and equipment necessary for rolling-in tube ends is eliminated.

And, too, Seco bends can be as easily removed, which is of decided advantage when tube renewal is necessary. The time that a still must be kept off-stream to replace a damaged tube is greatly reduced.

Seco Return Bends have four other money saving advantages that it will pay you to know about. Complete information will be sent promptly on request.

SECO RETURN BENDS

Smith Engineering Company
109 West Linwood Blvd.,
Kansas City, Mo.

Dodge Steel Company
6501 Tacony Street
Philadelphia, Pa.

F A M O U S N O R T H A M E R I C A N S

And Here Is the Most Famous of All North Americans

(As Any Child Will Tell You)

Other nations may differ with us in calling the gentleman pictured above a Famous North American. But we think we can prove our point.

Isn't the home of Santa Claus the North Pole? And wasn't Peary, an American citizen, the first man to reach the Pole? Why, then, can't we claim Mr. Claus as a citizen of this continent?

At any rate, we hope that the bag this North American carries will be opened wide when he arrives at your house—and that among his gifts will be much happiness and a great deal of prosperity for 1930.

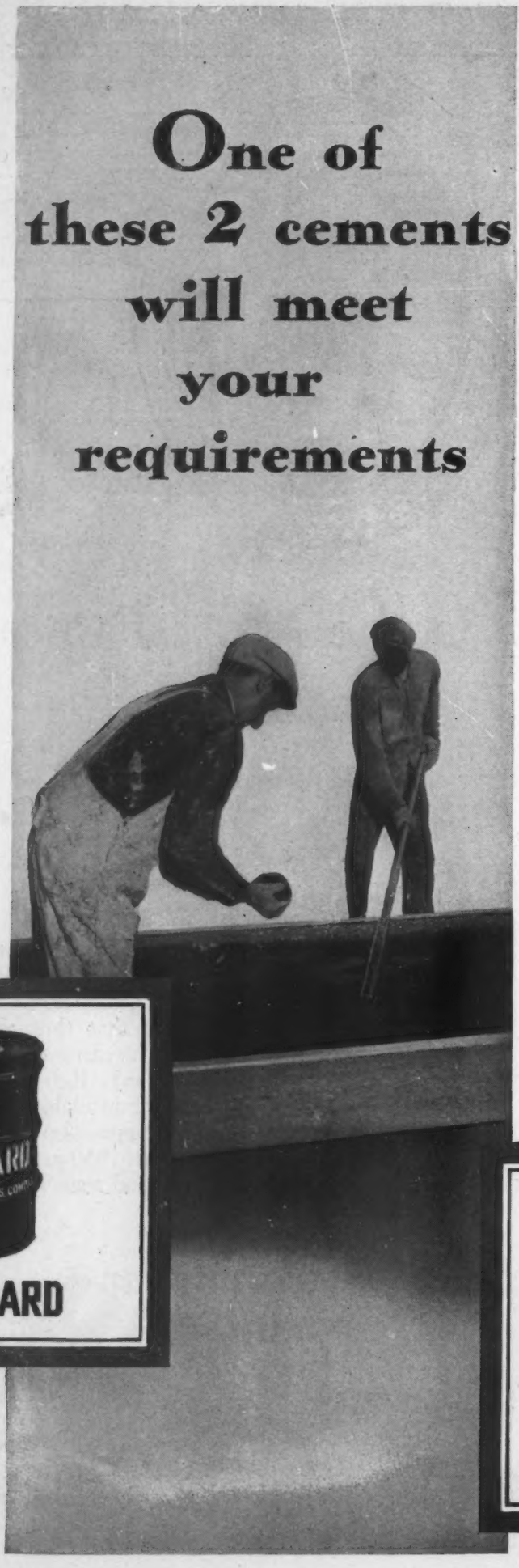
Perhaps we can contribute in a material way to this prosperity. A North American Lease, entered into now, will assure you that throughout 1930 your goods will be carried in the *most modern* type of Tank, Refrigerator and Palace Poultry Car available—cars that help to create an impression of *quality* and *stability*. With 1930 just around the corner, this is a good time to investigate.

North American Car Corporation

Executive Offices: CHICAGO, ILLINOIS

Car Shops		Bulk Oil Warehouses
Chicago, Ill.	Coffeyville, Kan.	Chicago, Ill.
Tulsa, Okla.	North Judson, Ind.	Tulsa, Okla.

One of these 2 cements will meet your requirements



GREFCO, a chrome base cement, is neutral in its chemical characteristics. It is ideal for severe furnace conditions and high temperatures, particularly where slagging action is severe.

STANDARD Silica Bonding Cement, another General Refractories product, is suitable for applications where temperatures are lower and the service is not so severe.

Refiners' individual service requirements can be adequately met by one of these two G. R. High Temperature Cements.

General Refractories is also prepared to meet your requirements for fire clay and high alumina refractories. The service is complete.

Ask for recommendations to meet your conditions.

GENERAL REFRACTORIES CO.

106 South 16th St., Philadelphia, Pa.

District Offices:
Boston, Buffalo, Chicago, Cleveland, Detroit, Indianapolis, New York Pittsburgh San Francisco

Representatives:
Seattle, Washington Montreal, Canada Havana, Cuba

3814

NATURAL GASOLINE *plus*...
SOUTHWESTERN RECTIFICATION

will produce
AN AVIATION GASOLINE-DIRECT PRODUCT
LIQUIFIED PROPANE AND BUTANE-DOMESTIC FUELS
A STABILIZED GASOLINE-MINIMUM STORAGE & TRANSPORTATION LOSS
A GASOLINE OF ANY GRADE TO SUIT MARKET CONDITIONS

FULL AUTOMATIC CONTROL — QUICK AND CLOSE REGULATION

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ROOM 1217 MAGNOLIA BLDG., DALLAS, TEXAS

TRANSPORTATION BLDG.
MONTREAL, CANADA

Billions of Bubbles

ASK THE OPERATOR

AN OPERATOR recently said, "You can always pick out a Campbell plant operator by the steadiness of his nerves."

There's something to think about. Plants built with the operators in mind are plants with a high-quality product in mind. Never can get away from the human equation.

Campbell engineers, on top of their technical training, serve a set apprenticeship in plant operating—just to learn the equipment from the operator's angle. When engineer and operator work hand in hand, results are bound to be satisfactory. Ask the operator.

Send for our Catalog today.

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Natural Gas Engineers

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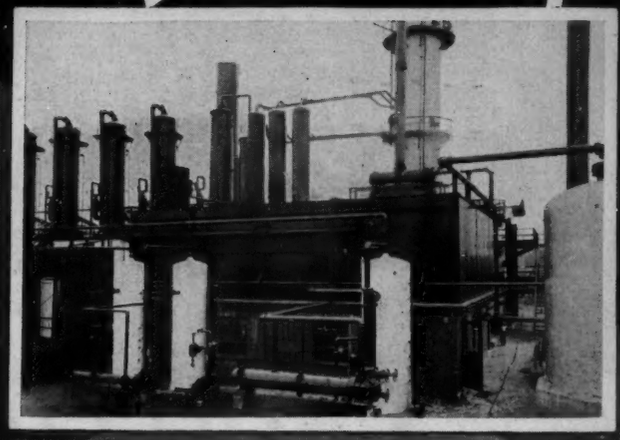
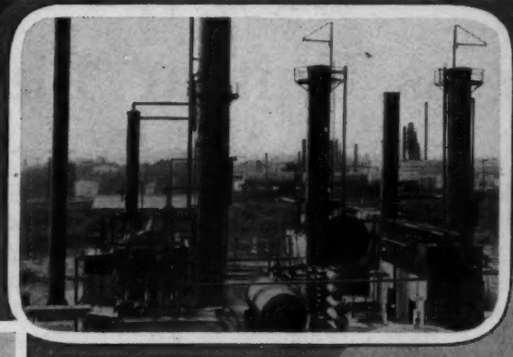
LONG BEACH, CAL.

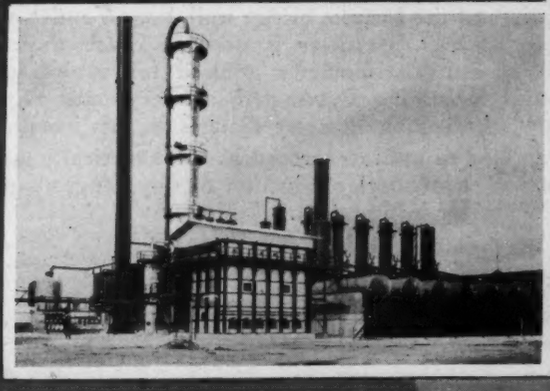
STEARNS-ROGER MFG. CO., DENVER
MID-CONTINENT AGENCY

Originators of Oil-Froth Absorbers

POSITIVE PROOF!







Proof—The past successful record of this company of highly specialized and competent engineers, devoting their entire time to the refinery industry, proves conclusively that they can efficiently handle your problems. The demands of the refiners for faster, better and more economical production have been met so successfully by this competent firm that today over sixty of the nation's leading refiners rely upon their counsel. Take your problems to them. Complete information of their service will be sent on request.

The WINKLER-KOCH ENGINEERING Co.

Consulting and Construction Engineers

FIRST NATIONAL BANK BLDG.
WICHITA, KANSAS

CALIFORNIA OFFICE, 1205 PACIFIC NATIONAL BANK BUILDING, LOS ANGELES

Controlling

Cross Unit at Lincoln Refining Co.

IN line with the general practice now followed by refineries producing quality products, within close competitive cost limits, the Lincoln Refining Company, Robinson, Illinois, has installed highly modern and efficient instrument equipment for still and tower control.

The installation shown above is used to control the cross cracking unit at this plant. The instruments include a Brown Duplex Pyrometer and CO_2 Meter to record $\%CO_2$ in flue gases and temperature of preheated air; also temperatures of flue gases entering and leaving the preheater. There are Brown Pyrometers to record temperatures of the furnace bridge wall, hot oil outlet, vapor separator, preheater oil outlet, etc. A Brown Indicating Pyrometer is used to check these and various other temperatures all along the line. A Brown Thermometer is used for recording the lower temperatures. The Brown Automatic Control Recording Pyrometers on the board regulate tower temperatures. There are also several Brown Indicating Pressure Gauges in this installation.

Brown Instruments can be advantageously applied to indicate, record and automatically control temperatures, pressures, liquid levels, etc., for the economical production of any range of petroleum products within close specification limits. Write for information.

THE BROWN INSTRUMENT COMPANY
4498 Wayne Avenue, Philadelphia, Pa.
Branches in 20 principle cities

Brown Automatic Controls

"To measure is to economize"

Western Refinery Equipment

It is seldom, in refinery service, that any two problems in construction and design are the same — expert engineering is necessary — backed by fabricating and construction resources for the correct and prompt erection of approved plans.

Our large, competent, staff of engineers are thoroughly experienced— our big shops are modern and properly equipped to turn out work quickly and correctly.

May we have your inquiries?

THE WESTERN GAS CONSTRUCTION COMPANY
FORT WAYNE INDIANA

Subsidiary of the Koppers Company

"Here, Lad—

You've been talking a lot about the Lincoln 'Stable-Arc' welder but it's only a name to me.

Now that we've got to watch our production costs so closely we should forget names and affiliations and get a machine that's head and shoulders above those we bought on faith."

The Lincoln "Stable-Arc" Welder

— welds easier
— makes better welds
— permits greater output

because of the steady uniform arc throughout entire welding range, which is the result of:

Variable voltage design
Laminated magnetic circuit
Separately-excited generator field
Double control of welding heat
All steel construction

No other welder has all these features.

"Fine, Pop—

and that means 'Stable-Arc'—the improved 'Stable-Arc'—only it's more than head and shoulders—it's also hands and feet ahead.

The improved model is HANDS ahead because with its *unified, centralized* and *simplified* control and everything in easy reach, the operator uses his hands chiefly for welding.

It's also FEET ahead because at the end of the day an operator has far more feet of welding to his credit. The Lincoln is admittedly the fastest machine (see points at left).

And when you take into consideration that all the controls are mounted together you just have to think of a new measurement for its betterment.

I see in the paper where a New York physicist claims that no two objects in the universe can be more than 54,000,000,000,000,000,000 miles apart—which shows that he's never attempted to measure just how far the Lincoln is ahead."

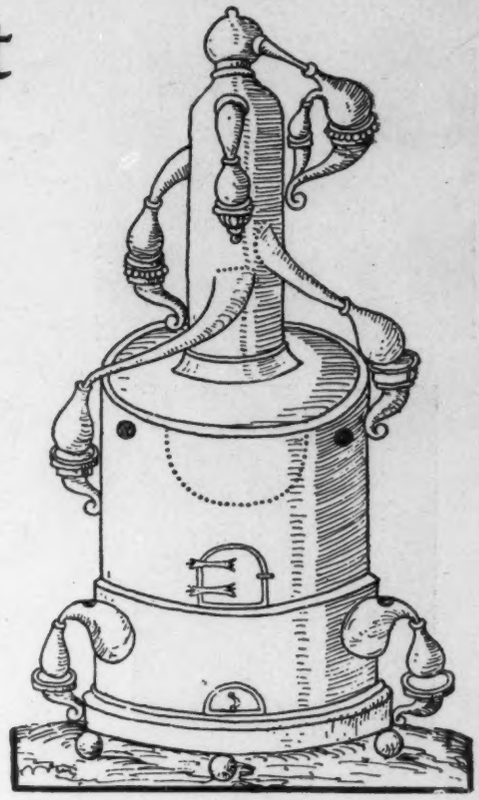
The Lincoln Electric Co.,
Dept. No. 34-12, Cleveland, O.

LINCOLN "Stable-Arc" WELDER

W-119

in 1553 the alchemist Porta wrote:

"Now we speak of oyles. These require the industry of a most ingenious artifycer, for many of the most excellent essences of things do remain in the oyl so that without the greatest art, wit, cunning and pains they cannot be brought to light, so that the whole art of distillation dependeth on this"



(Libavius, *Alchymia*, Frankfurt, 1606)

and in 1929

it is equally true

The
Walter E. Lummus Co.
Petroleum Refinery Construction

148 State St., Boston, Mass.
NEW YORK OFFICE · · · · · 30 CHURCH STREET

Oil Refining Equipment

IMPREGNATOR SHELL

We build all types of equipment such as:

TOWERS

AGITATORS

ABSORBERS

TANKS

CONDENSER BOXES

EXCHANGERS

ANGLE BENDING

STILL BOTTOMS

FABRICATED PLATE WORK

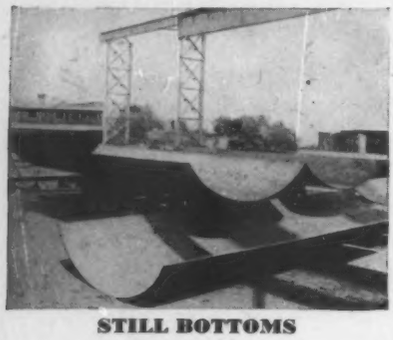
SPECIAL MACHINERY

Estimates on Request

HIGH PRESSURE HEAT EXCHANGER

SPECIAL CONE (15 ft. diameter)

SPHERICAL HEAD (15ft. diameter)



STILL BOTTOMS

SPECIAL HEAVY TANKS

SUN SHIPBUILDING & DRY DOCK CO.

CHESTER, PA., U. S. A.

NEW YORK PHILADELPHIA

Engineering Ability

The benefits of the knowledge obtained thru 37 years experience in valve manufacture are available to you, without obligation, in figuring on special valve jobs for your refinery.

Almost daily, engineers come to us with special valve problems. The valve illustrated (an 8″ cast steel three-way with two 4″ straight-ways in the same body) was developed especially for oil refinery service to handle hot oil.

This unusual valve is the result of a contact between our engineering staff and the Development Engineer of one of America's foremost Petroleum Refiners.

This engineer was so well pleased with the ability and willingness of our staff, that a large order was placed within a few days.

You, too, will find us well equipped and willing to serve on your special valve problems. Write us about your new developments or if you prefer we will try to send a man to discuss your problems personally.

A copy of our new catalog Number thirty-five, showing all types of Homestead Valves will be sent upon request.

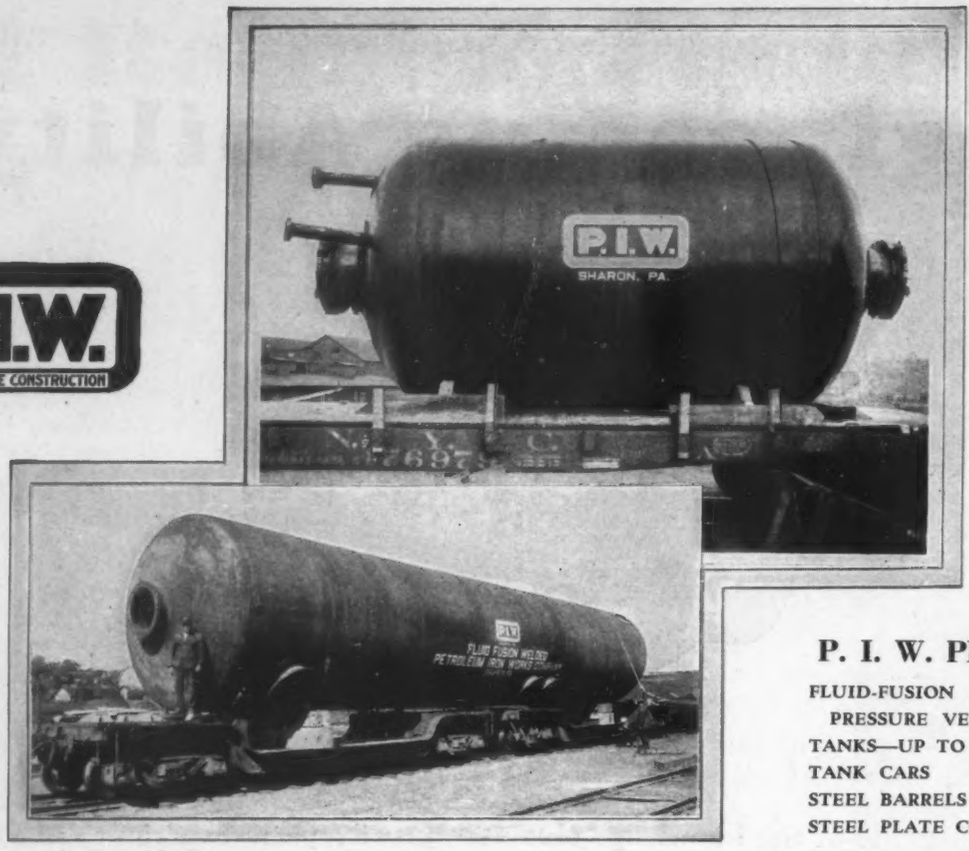
Homestead Valve Manufacturing Company, P. O. Box H, Coraopolis, Pa.

HOMESTEAD VALVES

QUARTER TURN VALVES:
STRAIGHT WAY
THREE WAY
FOUR WAY
LUBRICATED TYPE
ROUND OPENING REFINERY

PROTECTED SEAT VALVES:
HYDRAULIC (B & O. PAT.) OPERATING
REMOTE CONTROL
GLOBE
ROSS AIR SHUT-OFF VALVE
HOVALCO BLOW-OFF VALVE

P.I.W.
STEEL PLATE CONSTRUCTION



P. I. W. PRODUCTS

FLUID-FUSION WELDED HIGH PRESSURE VESSELS
TANKS—UP TO 120,000 BARRELS
TANK CARS
STEEL BARRELS AND DRUMS
STEEL PLATE CONSTRUCTION

SAFETY for HIGH PRESSURE OPERATIONS

Your high pressure operations are conducted in safety when Fluid-Fusion welded vessels are used.

The absence of common restrictions in the Fluid-Fusion manufacturing method permits the designing engineer to bring his vessel into safe conformity with the operation conditions regardless of pressure or temperature. P. I. W. precision fabrication, automatic control of Fluid-Fusion welding, complete furnace annealing, exhaustive testing during each manufacturing phase—result—a safe engineering design has been transformed into a safe high pressure vessel.

A P. I. W. engineer will gladly tell you more about Fluid-Fusion welded pressure vessels.

THE PETROLEUM IRON WORKS COMPANY
Sharon, Pa.

NEW YORK CHICAGO TULSA

FLUID-FUSION WELDED CRACKING VESSELS

A hard metal, impinging upon a softer . . . iron upon brass . . . makes a perfect seat for the Improved Kewanee Flange Union. The brass seat is now rolled in—literally forced into its groove under tremendous pressure. It is there to stay.

Another new feature of the Kewanee Flange Union design is heavier construction which, with the increased number and size of the bolts in certain sizes, gives this union a higher rating of 200 pounds Working Steam Pressure and 300 pounds Oil Working Pressure.

Its famous old principle of a ground joint iron-to-brass seat eliminates the use of a gasket and keeps the joint tight even when the pipe gets out of line.

All Kewanee Flange Unions are individually tested before shipment.

WALWORTH

Walworth Company, General Sales Offices: 51 E. 42nd St., New York
Plants at Boston, Mass.; Kewanee, Ill.; Greensburg, Pa.; and Attalla, Ala.

. . . Distributors in Principal Cities of the World . . .

Walworth Company Limited, 620 Cathcart St., Montreal, P. Q.
Walworth International Co., 11 Broadway, New York, Foreign Representative

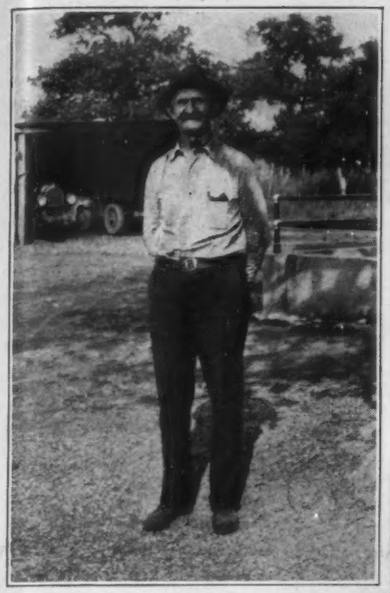
AVAILABILITY

THE real value of a distributing organization can be measured by how well it serves the needs of individual customers. In a word, availability to all purchasers must be assured. The location of Mathieson plants near the principal consuming centers insures prompt shipments, regardless of quantity, while a nation-wide chain of a hundred warehouse stocks serves the needs of Mathieson customers requiring limited quantities on short notice. This distributing service is an essential factor in the Mathieson policy of guaranteeing quality and satisfaction to every purchaser of Mathieson Chemicals.

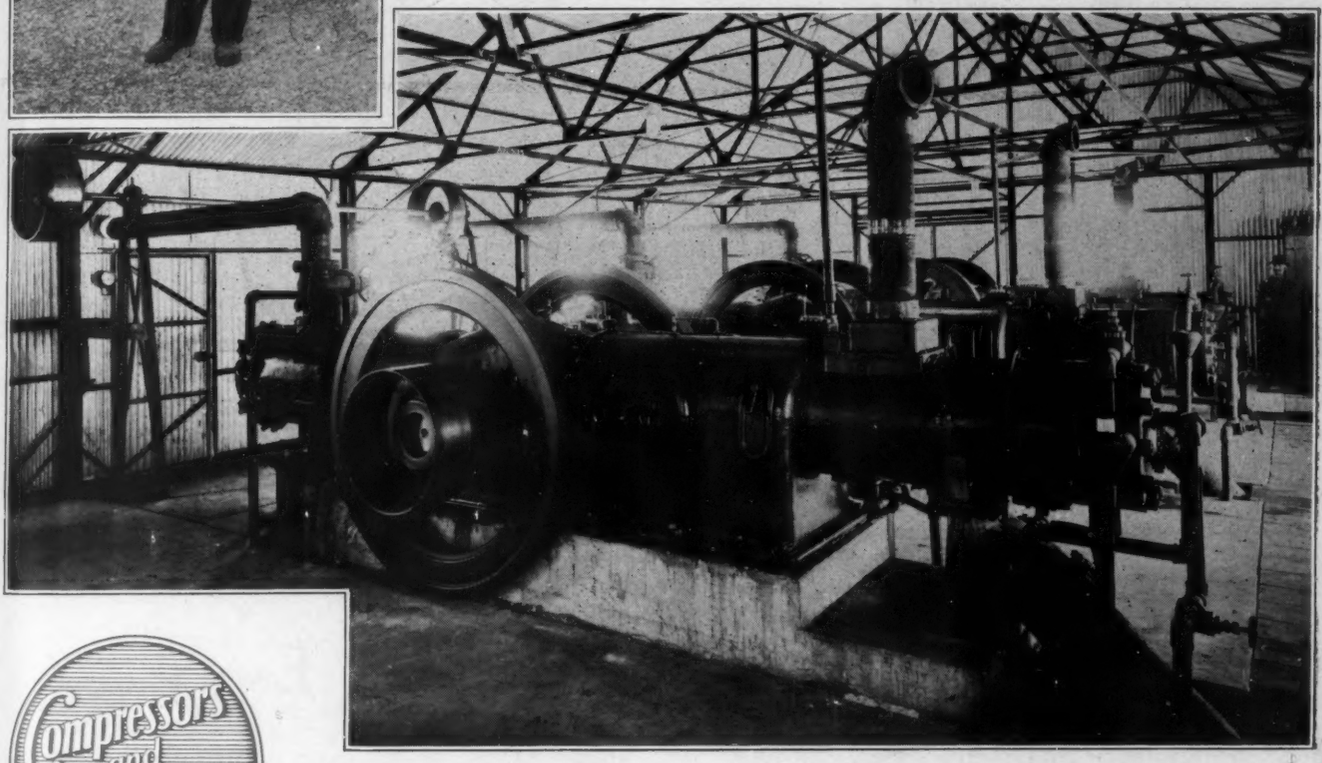
Soda Ash
Caustic Soda
Liquid Chlorine
Bleaching Powder
Bicarbonate of Soda
Ammonia, Anhydrous & Aqua
HTH (Hypochlorite)
PURITE (Fused Soda Ash)
Sulphur Dichloride

The MATHIESON ALKALI WORKS *(Inc.)*
250 Park Avenue, New York City
Philadelphia Chicago Providence Charlotte Cincinnati
Works: Niagara Falls, N.Y. Saltville, Va.
Warehouse Stocks at all Distributing Centers

MATHIESON CHEMICALS



"The Least Expensive & Smoothest Operating Engine."



Compressors and Gas Engines

CLARK BROS. COMPANY
OLEAN, N. Y.

Export Office:
150 Broadway, New York, N. Y.
Mid-Continent Sales Offices:
Tulsa and Fort Worth

Warehouses:
Tulsa, Okla.; McCamey and Sweetwater, Texas; Artesia, N. M.

California:
Smith, Booth, Usher Company, 228 S. Central Ave., Los Angeles

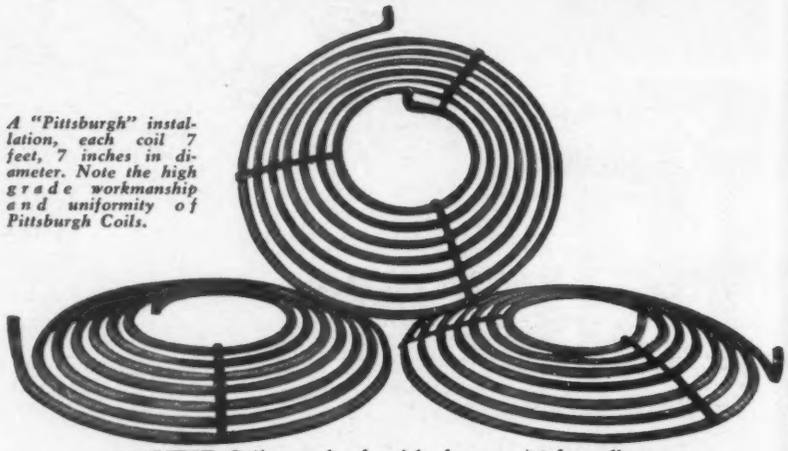
Mr. A. B. Nigh (above) Superintendent of the J. H. Wright Gasoline Plant at Kelleyville, Okla., is one of the oldest gasoline plant superintendents in the Mid-Continent. After his many years experience with various makes of engines, Mr. Nigh claims that the CLARK is the least expensive and smoothest operating engine he has ever operated. Operators everywhere like the CLARK because of its dependability and low maintenance cost. Ask for data on The CLARK "Super 2" which saves 1/3 the fuel required by ordinary 2-cycle compressors.

CLARK

Pittsburgh AIR PRESSURE TESTED Coils

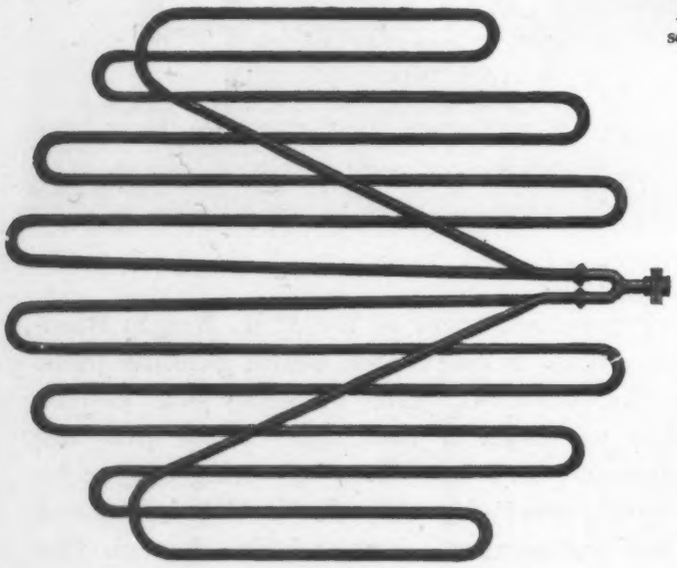
built for oil country and refinery use

ELECTRICALLY welded, continuous — no couplings, no pipe fittings. That is the way Pittsburgh Coils are built for oil country and refinery use.



A "Pittsburgh" installation, each coil 7 feet, 7 inches in diameter. Note the high grade workmanship and uniformity of Pittsburgh Coils.

THESE Coils can be furnished up to 10-foot diameter in continuous coil; larger diameters are furnished in sections.



Pipe Bends
any Degree

All sizes up to six-inch. Furnished with steel protectors to safeguard the threads.

EACH individual Coil is tested before shipment — tested under heavy air-pressure while submerged in water. "There's not a leak in a mile of Pittsburgh-built Coils."

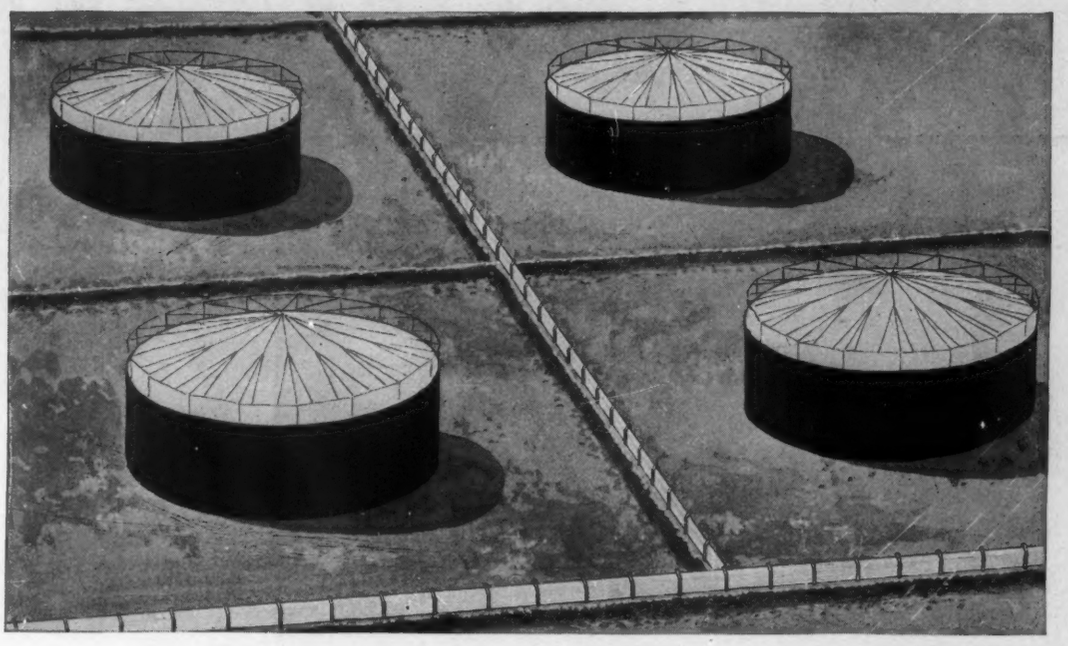
Proved absolutely secure, each Coil is serially numbered and tagged for identification—and for your protection. The metal tag is our word to you that the Coil is O. K.

You can get Pittsburgh-built Coils for all your requirements. Simply send us a blue print, rough sketch, or description for a prompt quotation.

There is extra service for you and a new measure of satisfaction in Pittsburgh-built Coils.

Pittsburgh Pipe Coil & Bending Company
P. O. Box 975, PITTSBURGH, PA.

Confine Your Oil Tank Fires!



With Economical Flare-Backs of TRANSITE

THE wise oil company guards its oil tanks with flare-backs of Transite. By separating the tanks in rows as shown in the above picture, and by using Transite instead of brick or tile, low cost construction is obtained and fire hazard from "boil-overs" is positively controlled.

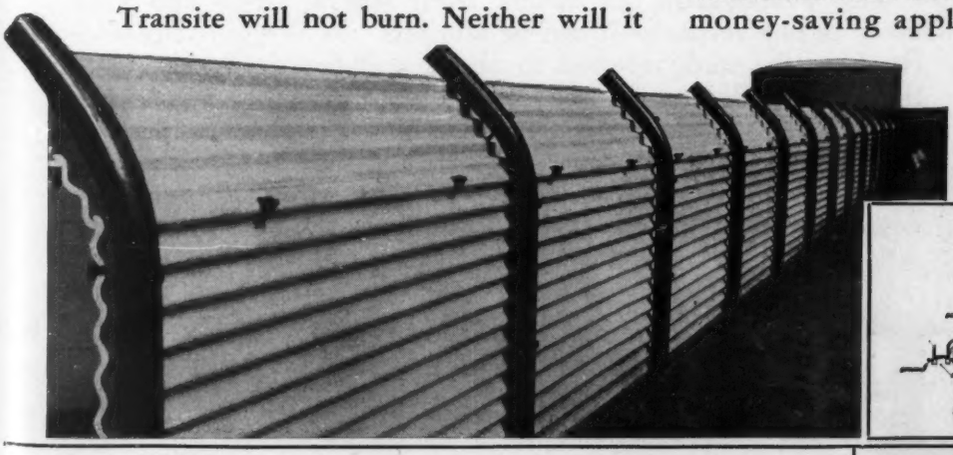
Transite is the ideal material for flare-back construction. It is made of indestructible asbestos and Portland Cement, moulded under tremendous pressure into solid homogeneous sheets.

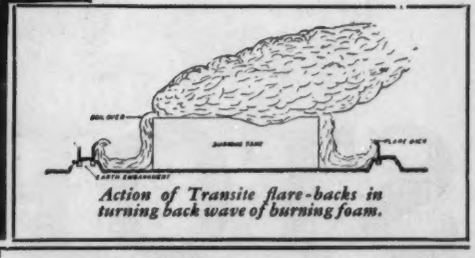
Transite will not burn. Neither will it rust, rot or corrode. It will last a lifetime.

Easy to Erect, Dismantle, or Re-erect

While flare-backs constructed of brick, tile or concrete are expensive to erect and difficult to move, flare-backs of Transite are inexpensive to erect and can be easily dismantled and re-erected. Transite is more efficient because it eliminates upkeep costs and permits the overhung top construction necessary to efficient operation.

Our engineers will gladly give you full information and show you worth while and money-saving applications of Transite —the imperishable, fireproof construction material.





Action of Transite flare-backs in turning back wave of burning foam.

Johns-Manville

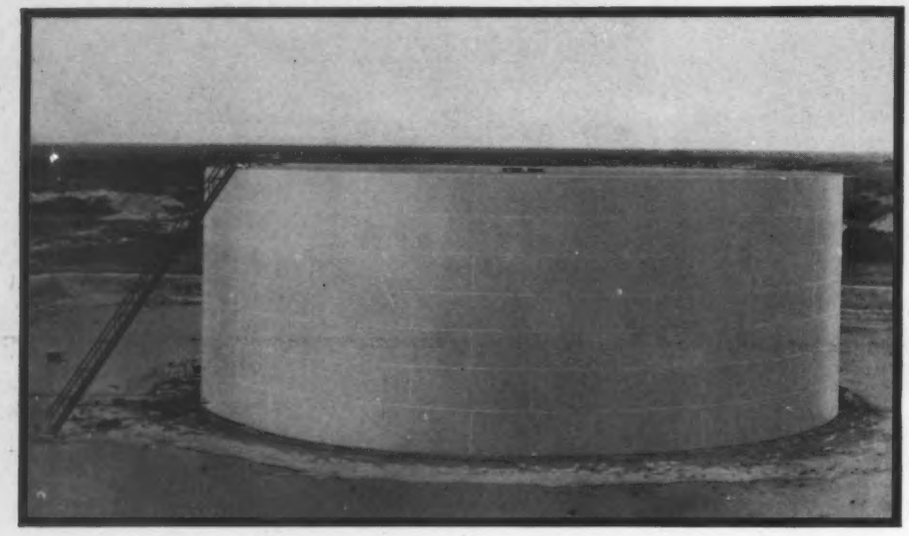
TRANSITE FLARE-BACKS

JOHNS-MANVILLE CORPORATION
New York Chicago Cleveland San Francisco Toronto
(*Branches in all large cities*)
Please send me full information regarding Transite Corrugated Flare-backs.

Name.....

T-54-12

Address.....



Wiggins Breather Roof on 80,000-barrel tank of Humble Pipe Line Co., Ingleside, Texas.

Evaporation Taxes Your Oil

You don't go to the collector's office to pay the tax exacted by evaporation. Nature draws directly on the liquid assets in every one of your ordinary cone-roofed tanks.

If you paid this tax in cash instead of oil, your annual check for a single tank storing 55,000 bbls. of motor fuel gasoline would be from $3,000 to $4,000. On all your tanks the loss would probably dwarf your present tax bill, unwelcome as it is.

This evaporation tax differs from federal, state and local taxes in one respect—it can be stopped. A Wiggins Breather Roof on the tank referred to above will practically eliminate the loss, by flexing up and down as the air-vapor mixture in the tank expands and contracts. No air is drawn in as the temperature goes down and no vapor is "breathed" out as the temperature increases. The additional cost over an ordinary roof is paid for in savings in 12 to 18 months; after that the savings are "gravy." Ask our nearest office for estimates.

Ask for a copy of this booklet.

STOP EVAPORATION LOSSES

CHICAGO BRIDGE & IRON WORKS

Dallas	3338 Magnolia Bldg.	Detroit	1515 Lafayette Bldg.
Chicago	2142 Old Colony Bldg.	Philadelphia	1613 Jefferson Bldg.
New York	3144 Hudson Terminal	Boston	1518 Consolidated Gas Bldg.
Cleveland	2241 Union Trust Bldg.	San Francisco	1050 Rialto Bldg.
Havana, Cuba	Apartado 2507		

with WIGGINS BREATHER ROOFS OW11-22-Gray

Here's What 5-Point Pipe Means In Cooling Tower Savings—

A large oil refinery (name on request) constructed a cooling tower of Reading 5-Point Pipe, using also a small section of ordinary pipe. The 5-Point Pipe had previously been used for 18 months as well tubing, while the ordinary pipe had seen only three months of such service. At the end of fifteen weeks, the section of the tower made of ordinary pipe had to be junked because it was so badly corroded. At the end of ten months, the Reading 5-Point Pipe showed no sign of corrosion—there was no formation of rust or scale to impair cooling efficiency, even though raw creek water was used as a cooling medium!

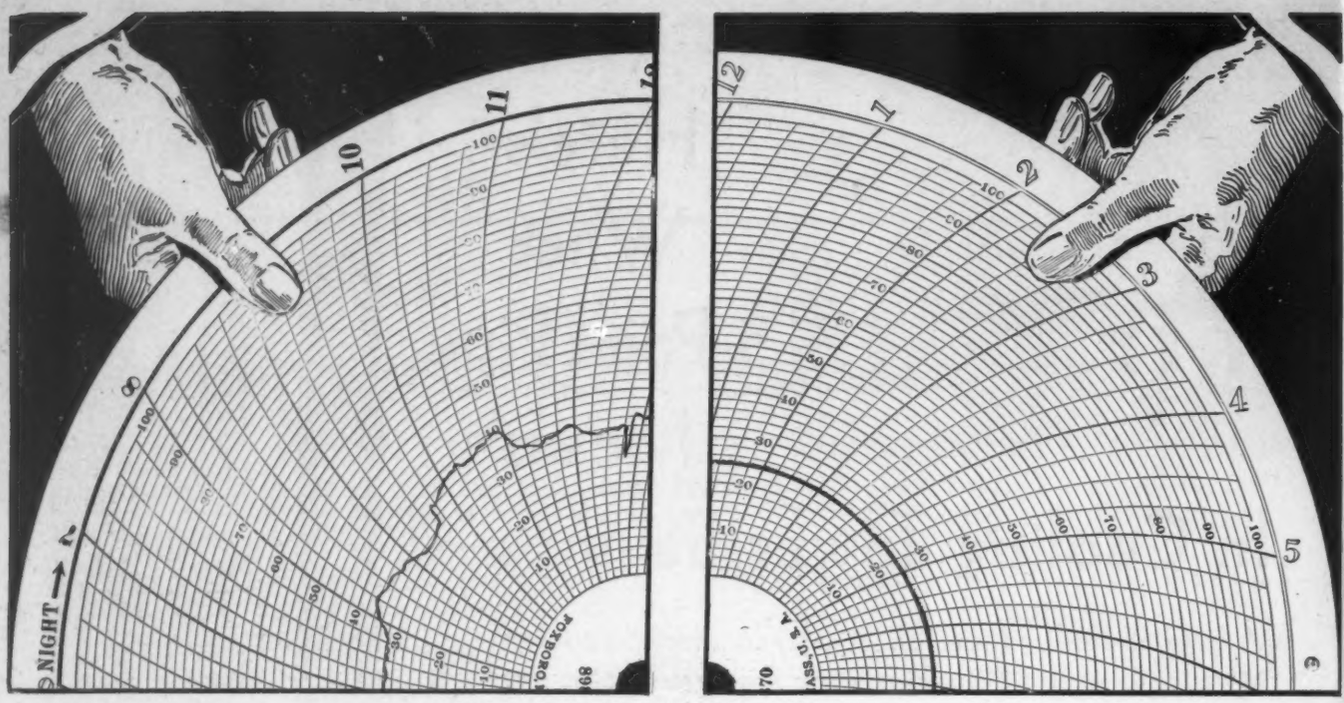
Such service is common with Reading 5-Point Pipe because it is made of corrosion-resisting Genuine Puddled Wrought Iron—double-welded for extra strength. Get the benefit of its remarkable savings—insist on getting Reading Genuine Puddled Wrought Iron Pipe.

READING IRON COMPANY, Reading, Pennsylvania

Atlanta · Baltimore · Cleveland · New York · Philadelphia
Boston · Cincinnati · St. Louis · Chicago · New Orleans
Buffalo · Houston · Tulsa · Seattle · San Francisco
Detroit · Pittsburgh · Fort Worth · Los Angeles · Kansas City

As an added improvement all Reading Galvanized Couplings for Reading 5-Point Tubing are now furnished with galvanized threads.

GENUINE PUDDLED WROUGHT IRON
READING PIPE
DIAMETERS RANGING FROM ⅛ TO 20 INCHES



Which Chart do you Choose?

Look at these two charts. Which one do you choose? The record to the right was made by a Foxboro Flow Controller on the oil line to a still. See how steady the flow was. Not a variation. Compare this record of Foxboro Automatic Control with the record of the same process (at left) regulated by hand. Can there be any doubt as to the desirability of Foxboro Automatic Control?

With a constant rate of flow of oil to the still, tower temperatures and vapor velocities up through the tower are more uniform. Operators can cut fractions closer, get a better grade of distillate at a saving in operating expense.

Foxboro Flow Controllers operate independdently of line pressures. They are guaranteed to do their job of controlling flow right. You can depend on them.

Write the nearest Branch Office for a Foxboro Engineer to come to your plant. Go over the matter with him. He will explain the application and installation more fully.

The Foxboro Guarantee, sealed to each Recording and Controlling Instrument

THE FOXBORO COMPANY

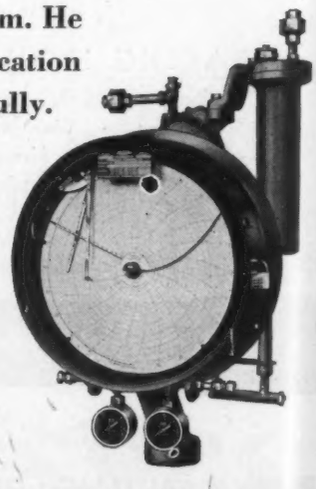
Neponset Avenue, Foxboro, Mass., U. S. A.

28 North Guthrie Ave., Tulsa, Okla. Magnolia Building, Dallas, Tex.
J. E. Treacy, Strada Golesti No. 9, Ploesti, Roumania
New York Chicago Boston Philadelphia Pittsburgh
Cleveland Rochester, N. Y. Atlanta Los Angeles
San Francisco Salt Lake City Portland, Ore. Detroit
Agents for Robinson Patented Orifice Flange Fittings.

FOXBORO

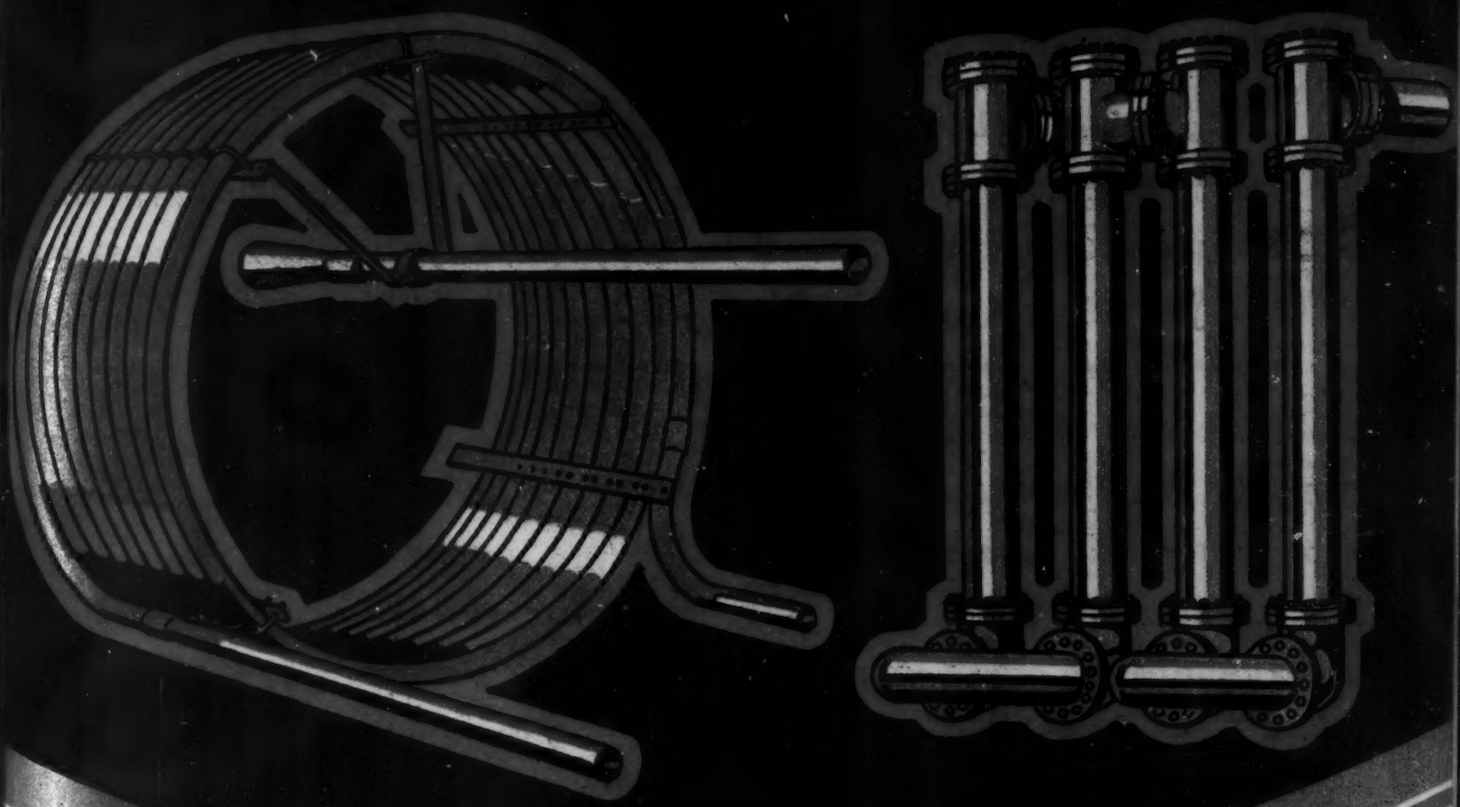
REG. U. S. PAT. OFF.

THE COMPASS OF INDUSTRY



Foxboro Flow Controller

INSTRUMENTS *for* CONTROLLING, RECORDING, *and* INDICATING TEMPERATURE, FLOW, HUMIDITY *and* PRESSURE



ENDURO NIROSTA KA2 *Controls High Temperatures - High Pressures - Excessive Corrosion*

DUE TO THE KRUPP patented method of processing, Enduro KA2 meets all requirements for installations subject to excessive corrosion, or where high temperatures are combined with corrosive attack. ¶ The distinctive characteristics of this improved chrome-nickel-iron alloy gives piping, tubes, wire, tanks, digesters, kettles, storage vessels, condensers, and countless other apparatus fabricated from this material, a life many times that of ordinary steel or other alloys. ¶ The high immunity of Enduro KA2 to corrosive attack—its unusual strength at high temperatures—freedom from embrittlement—and high resistance to oxidation, are effecting substantial economies in industry. ¶ To overcome costly losses now occurring where other metals are used, alert designers now specify Enduro KA2. It is available in all usual shapes and forms.

ENDURO

NIROSTA

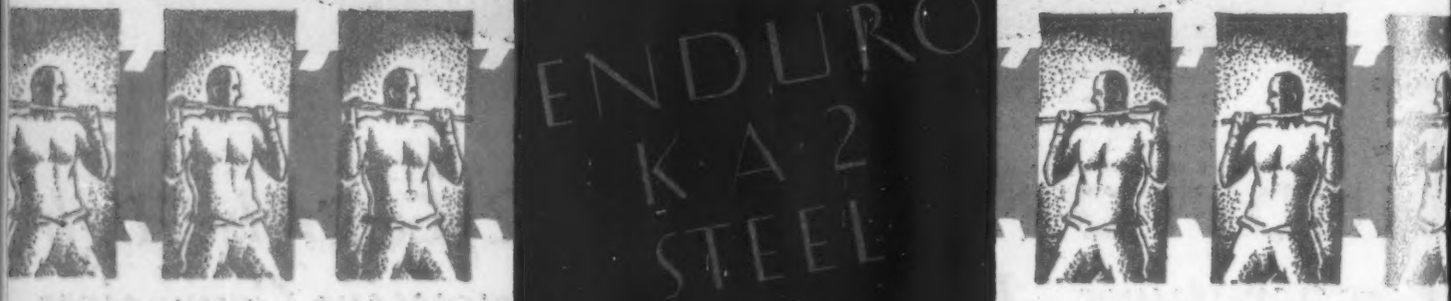
CENTRAL ALLOY STEEL CORP.
Massillon and Canton, Ohio

K·A·2 STEEL

THE BABCOCK & WILCOX TUBE CO.
85 Liberty Street, New York City, N. Y.

LUDLUM STEEL CO.
Watervliet, N.Y.

COMBINING high corrosion resistance with ready workability, Enduro KA2 is simplifying many problems of design and facilitating construction in industries where corrosive agents must be handled. ¶ Seamless tubes and pipe of this new chrome-nickel-iron alloy can be bent, threaded, flanged or otherwise formed with the same ease as ordinary steel. ¶ And the great strength and toughness of Enduro KA2 is likewise in marked contrast to the fragility of special non-corrosive materials such as glass, stoneware, and high silicon cast iron. ¶ For oil, acid and pressure lines, for heat exchanger tubing, condensers, and innumerable other apparatus subject to severe corrosion or high temperatures, Seamless Enduro KA2 is providing long economical service.



The booklet tells the history of Enduro—fully explains its many advantages and points out scores of its manifold uses. Write to any of the companies listed below for your copy.

ENDURO NIROSTA KA2 STEEL

CENTRAL ALLOY STEEL CORP.
Massillon and Canton, Ohio

LUDLUM STEEL CO.
Watervliet, N. Y.

THE BABCOCK & WILCOX TUBE CO.
85 Liberty St., New York City, N. Y.

SEAMLESS ENDURO KA2

—*Easily Fabricated*

Seamless Pipe of Enduro KA2 expanded at both ends and flattened (cold worked).

Seamless Enduro KA2 belled in the cold state.

Seamless Enduro KA2 flattened cold without any fracture.

THE working properties of Seamless Pipe of Enduro KA2 are similar to those of ordinary steel. It can be easily bent, threaded, flanged or otherwise formed, thus facilitating the work of installation.

This ease of working is in marked contrast to the fragility of special non-corrosive materials heretofore used, such as glass, stoneware, and high silicon cast iron.

Because of this outstanding advantage, Seamless Enduro KA2 is finding extensive use in many industries where agents corrosive to ordinary ferrous materials must be handled.

Seamless Pipe of Enduro KA2 is furnished with plain ends, threaded and coupled, or with flanges of Enduro KA2. Cast fittings of Enduro KA2 can also be supplied.

The Seamless Enduro KA2 booklet gives the chemical, physical and other properties of this new chrome-nickel alloy. Send for a copy.

Enduro KA2, manufactured by Central Alloy Steel Corporation, is fabricated into seamless tubes and pipe by

THE BABCOCK & WILCOX TUBE CO.

Works and General Offices:
Beaver Falls, Pa.

Seamless
ENDURO
NIROSTA
Tubes and Piping

General Sales Office:
85 Liberty Street
New York

SOLVAY PRODUCTS

58% SODA ASH

CAUSTIC SODA

Solid—Flake—Ground—Liquid

Leading refiners depend on these products for the quality and uniformity which industry inevitably associates with the name Solvay. First in pioneering the development of American sources of alkali, The Solvay Process Company is recognized as the outstanding leader of its field—first in size and first in facilities for rendering efficient service.

Strategically located distributing points ensure prompt delivery of Solvay products with minimum transportation charges.

Write today for prices and full information

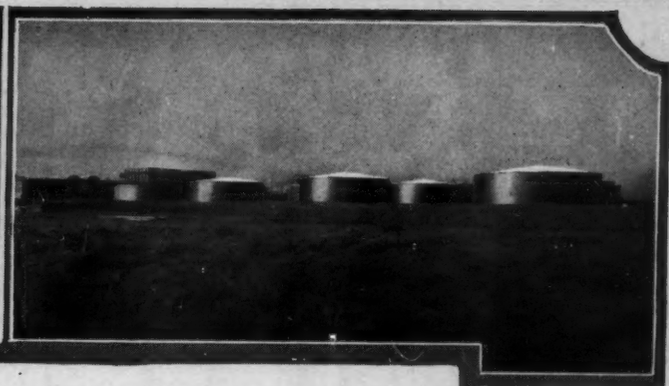
SOLVAY SALES CORPORATION

Alkalies and Chemical Products Manufactured by The Solvay Process Company

New York

40 Rector Street

"SOLVAY" Trade Mark Reg. U. S. Pat. Off



"The Sun Never Sets on Hamondtanks"

The "Copyrighted Slogan" tells the story.

In every country where Petroleum Products are stored in steel tanks Hammond Tanks are used.

Steel tanks in capacities up to 100,000 barrels; knocked down or erected.

Oil Refinery Equipment, Stills, Towers, Agitators, etc.

Send for—

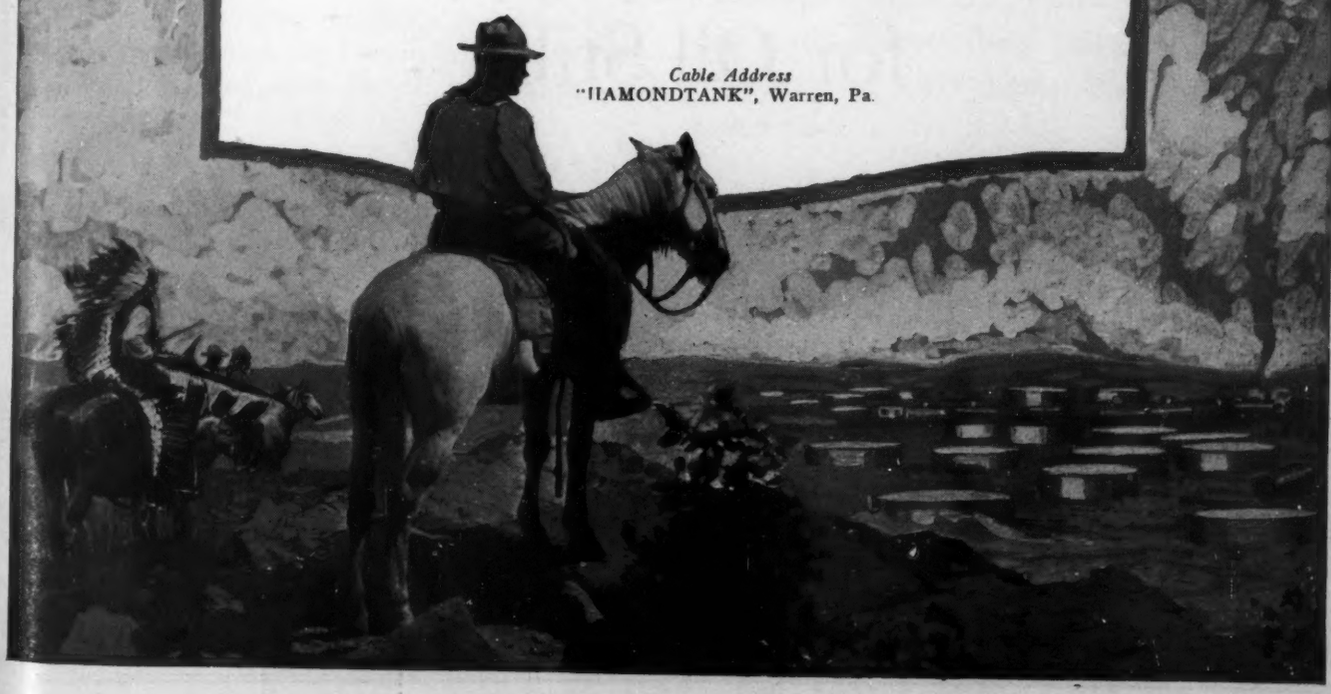
Our Bulletin No. 300—Hammond Filters.
Our Bulletin No. 200—Storage Tanks.
Special Bulletin—Handling and Storing of Fuel Oil.

HAMMOND IRON WORKS

Warren, Pa., U. S. A.

New York Office: 17 BATTERY PLACE
Telephone: Whitehall 0060

Cable Address
"HAMONDTANK", Warren, Pa.



HYBNICKEL

HEAT and ACID RESISTING CASTINGS

Several hundred tons of Hybnickel are now in use in oil refinery stills and superheaters.

One of Our Main Products Is—

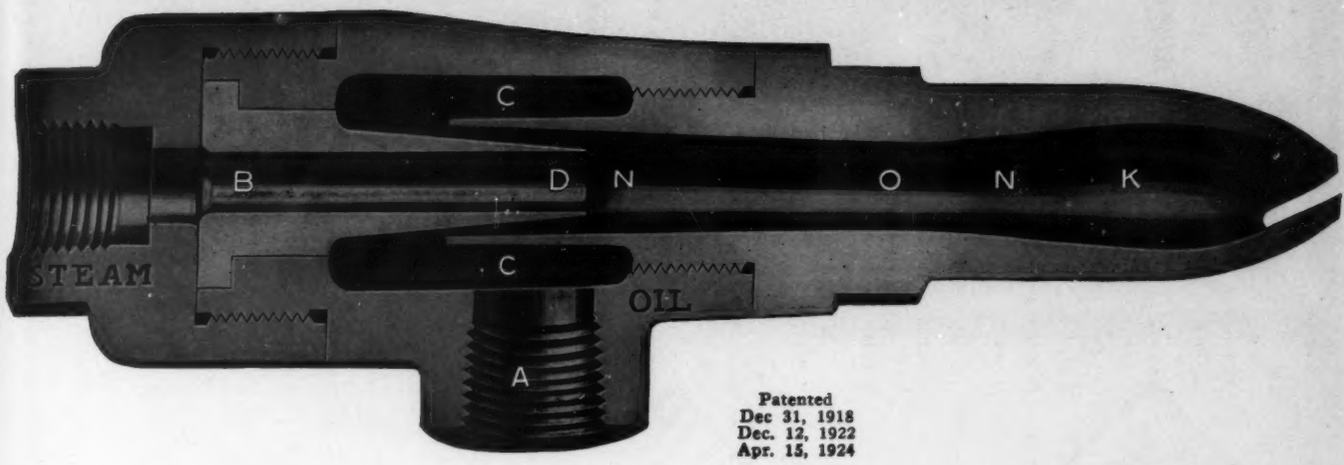
Heat-resisting supports for Oil Stills

VICTOR HYBINETTE

care of The Pusey and Jones Corporation

Wilmington, Delaware

National Airoil Burners



Patented
Dec 31, 1918
Dec. 12, 1922
Apr. 15, 1924

For Power Plants and Stills and all Industrial Furnaces

NATIONAL AIROIL BURNERS
are internal atomizing burners—inside mixers —operating with either steam or compressed air; and burn as steady as a gas flame with any grade of fuel. Set your fire the way you want it, and it will burn the day through without watching or readjusting.

NATIONAL AIROIL BURNERS
will handle the heavy residuum from cracking stills without requiring continual removal for cleaning, an immense factor in economical plant operation.

NATIONAL AIROIL BURNERS
when operating under boilers will use less than one per cent of the steam for atomizing the oil. The old style steam atomizing burners use from three to seven per cent.

NATIONAL AIROIL BURNERS
give a soft gaseous flame that does not injure brick work or boiler tubes. Made with flat or round tips.

Write for our Bulletin No. 21

National Airoil Burner Company

Factory: S. W. Cor. 9th and Thompson Sts.
Sales Rooms: 1327 Girard Avenue
PHILADELPHIA, PA.

Oil Burners and Oil Burning Equipment

PACK the fluid end of the pump with a packing that retains its lubricant against the washing out tendency of the fluid pumped. The following packings meet perfectly the various conditions specified:

PELRO PACKING

for

GASOLINE
NAPHTHA
KEROSENE
AMYL ACETATE (Banana Oil)
BUTYL ACETATE
ACETONE
BENZINE (Benzol)
TOLUENE (Toluol)
XYLENE (Xylol)
TURPENTINE
MINERAL SPIRITS
ETHYL ACETATE (Acetic ether)

PALMETTO PACKING

for

STEAM
(High pressure, superheat)
•
Compressed Air
•
ACIDS
OXALIC
PALMITIC
STEARIC
TANNIC
BENZOIC
BORIC
CITRIC
OLEIC
TARTARIC
ALKALIES
BORAX
SODIUM SULPHITE
MISCELLANEOUS
SODIUM BICARBONATE

GUTNO PACKING

for

ACIDS
Hydrochloric (Muriatic)
Acetic (Glacial and dilute)
Lactic
Nitric
Sulphuric (Oil of Vitriol)
Sulphurous
Phosphoric
STRONG ALKALIES
Sodium Hydroxide (Caustic Soda)
Potassium Hydroxide (Caustic Potash)
Sodium Carbonate (Soda Ash)
Potassium Carbonate (Potash)
Ammonia (Anhydrous and dilute)
Lime
ALKALINE SALTS
Borax
Sodium Sulphite
Sodium Cyanide
Potassium Cyanide
Sodium Sulphide
Potassium Sulphide
Sodium Silicate (Waterglass)
Tri-sodium Phosphate
Sodium Bisulphite
ORGANIC SOLVENTS
Methyl Alcohol* (Wood alcohol)
Ethyl Alcohol* (Grain alcohol)
MISCELLANEOUS
Chlorine
Bleach Liquor
Bromine
Lime Sulphur
Salt Cake
Alum
Hydrogen Peroxide
Creosote (Coal Tar)
* Concentrated and dilute

PALCO SQUARE PLAITED PACKING

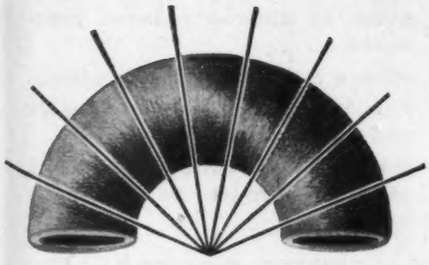
for

WATER
(Hot and cold)
•
CALCIUM BRINE
•
Centrifugal and Reciprocating PUMPS
•
Has high tensile strength and carries such an abundance of lubricant that shaft friction is avoided.

To prove our claims for long satisfactory service, let us send you without charge or obligation working samples of the above packings to test under your own conditions. State condition of service and size packing desired.

GREENE, TWEED & CO.

Sole Manufacturers 109 Duane St., New York



Can Be* CUT *to Make Any Required Angle

TUBE-TURNS are seamless drawn fittings, forged by an exclusive process from any specified metal. No thinning or thickening of walls. True, circular cross-section. Radius 1½ times nominal pipe diameter. Non-porous. Strong and safe as the pipe in the line, and with the same co-efficient of expansion. Odd angles easily cut at the plant *or on the job.* Regularly stocked in 180°, 90°, and 45° Iron Pipe Sizes—Standard or Extra-Heavy—by the distributors listed below.

IF YOU have already discovered the advantages of pipe welding, *you will be interested in the further savings and improvements now made possible by TUBE-TURNS.*

Because of their definite, tangible superiorities over every other type of fitting, the sale of TUBE-TURNS has increased more than 500% in the past year.

The complete story of TUBE-TURNS—their advantages, economies, and specifications—is given in Bulletin 103. *It will pay you to write for the facts.*

Address:* TUBE-TURNS, *Incorporated
***General Offices:* 1256 Logan St., Louisville, Ky.**

CHICAGO: *110 S. Dearborn St.*
NEW YORK: *30 Church Street*
PHILADELPHIA: *Bourse Bldg.*

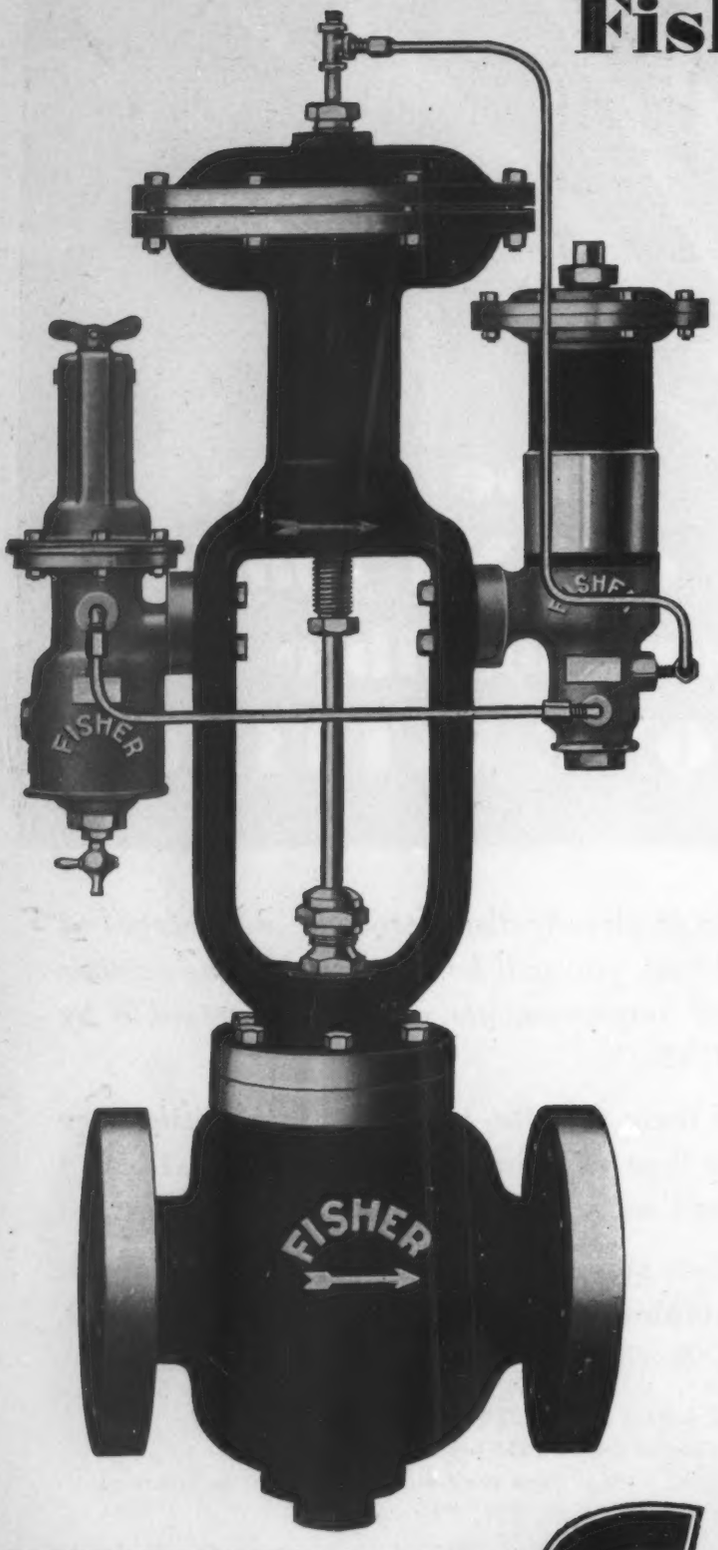
TUBE-TURNS

NO BUCKLING OF INSIDE WALL — NO THINNING OF OUTSIDE WALL

The Stock Fittings For Pipe Welding

DISTRIBUTORS: *Baltimore, Md.*, The Heat and Power Corp. • • • • *Cambridge, Mass.*, Baker Supply Co. • • • • *Cleveland, O.*, M. S. Maleson Co. *Detroit, Mich.*, C. E. Phillips and Co. • • • • *Houston, Tex.*, Maintenance Engineering Corp. • • • • *Los Angeles, Cal.*, Buck and Stoddard • • • • *Pittsburgh, Pa.*, Herr-Harris Company • • • • *St. Louis, Mo.*, H. A. Woodworth Engineering Company *Toledo, O.*, Mason Equipment Co. • • • • *Tulsa, Okla.*, The Moorlane Company • • • • *Honolulu*, Hawaiian Gas Products, Ltd.

Fisher Steps Ahead Again



The 2200 SERIES CONTROLLER is the result of over two years' designing, experimenting and developing by the Fisher engineers.

And with this announcement they show why and how they maintain their lead in the creation and manufacture of such devices.

The 2200 SERIES CONTROLLER provides all-purpose, ultra-sensitive, pilot-operated control for reducing pressures, holding back pressures, maintaining differential pressures and sustaining vacuums —within close limits.

It is especially designed for these types of installations:

(1) Where ultra-sensitive control is required.
(2) Where initial pressures drop close to desired reduced pressures.
(3) Where volume loads vary widely.
(4) For handling corrosive liquids and gases.
(5) Where adjustment to existing conditions must be unusually close.

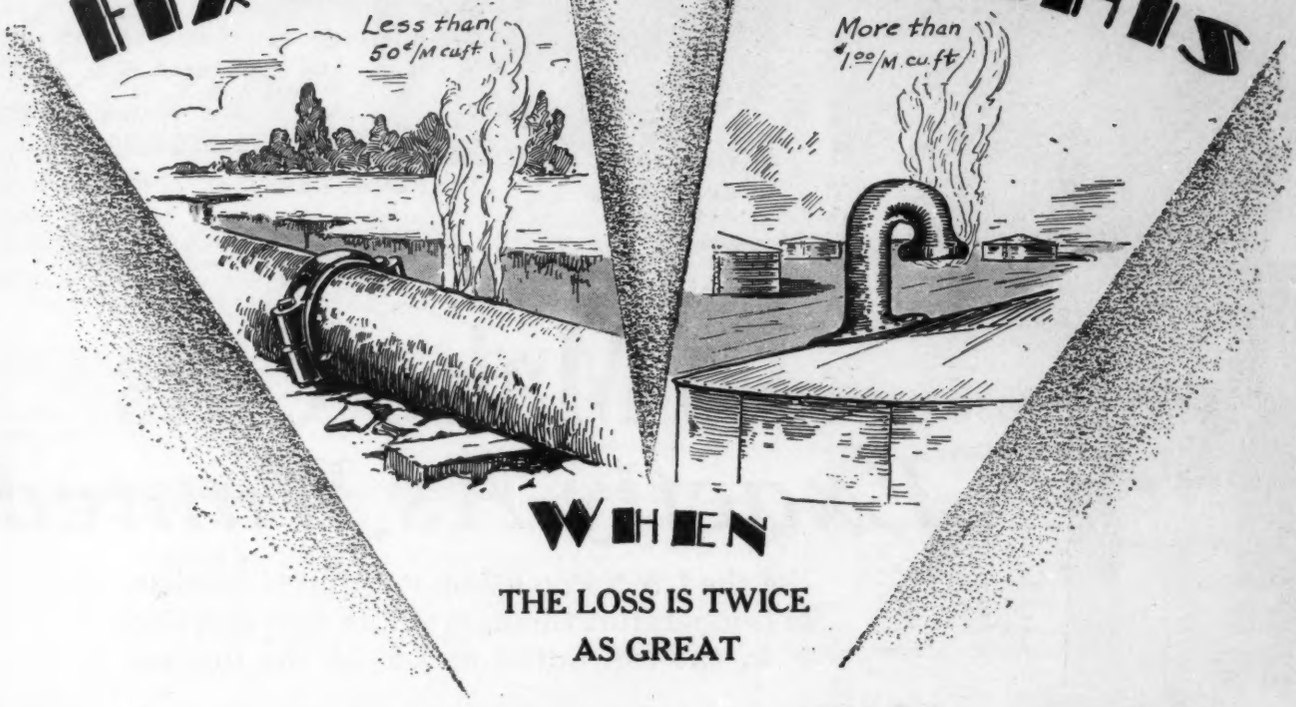
The 2200 SERIES CONTROLLER, in spite of the fact that it is most sensitive in control, is simple in design, free of exposed pistons, dash-pots, and similar trouble-causing devices — and unusually simple to install — with types for either vertical or horizontal pipe.

THE FISHER GOVERNOR COMPANY, Inc.
1300 Fisher Bldg.,
MARSHALLTOWN, IOWA

FISHER

WHY

FIX THIS AND NOT THIS



WHEN

THE LOSS IS TWICE AS GREAT

WITH gas at 50 cents per thousand cubic feet, a break in a gas main gets quick attention.

With gasoline at 9 cents per gallon, and 12 gallons on an average per 1000 cubic feet of gas as it escapes from the old fashioned vent, the loss per thousand is twice as great.

The cost of Oceco Fittings is very small compared with your losses, and the investment yields tremendous returns.

The Oil Conservation Engineering Company

877 ADDISON ROAD CLEVELAND, OHIO

Engineering and Sales Service:

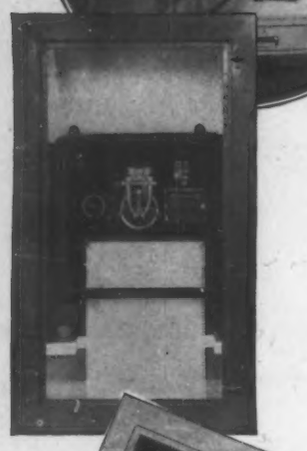
25 Broadway, New York
Box 552, Beaumont, Texas
Tulsa Trust Bldg., Tulsa, Okla.
Neilan, Schumacher & Co., Los Angeles, Cal.

This large battery of stills is a consistent profit-earner, due to L & N centralized control

Automatic Temperature Control

To Make Cuts *Exactly As Wanted*

Use the L & N Potentiometer that is Sensitive to Temperature Changes of 1° in the vapor line, 2° in the coil outlet and 5° in the furnace.



This 36-page booklet tells how refineries use L & N Pyrometers to bring about maximum yield. Write for

BULLETIN 870-R

WHEN the laboratory says that a given crude should run 26.2 per cent for a specified overhead at 895° in the still—it takes more than mere words to explain why it isn't being done. However, by using L & N Potentiometer Pyrometers to draw continuous records on 10-inch wide charts, you can show definite proof of temperature conditions—from furnace to condenser. In fact, you can repeat conditions within 2°.

Neither will atmospheric changes nor length of leads affect calibration. Compensation is electrically automatic.

Add full L & N control of fires, pressures, reflux, etc., and exact cutting becomes practically a setting of dials.

L & N Thermal Engineers Are At Your Service

LEEDS & NORTHRUP COMPANY

4901 STENTON AVENUE PHILADELPHIA, PA.

Branch Offices: Cleveland Chicago Houston Los Angeles San Francisco

P-126

LEEDS & NORTHRUP

L & N Potentiometer Pyrometers—Different From All Others—Most Accurate In Industry

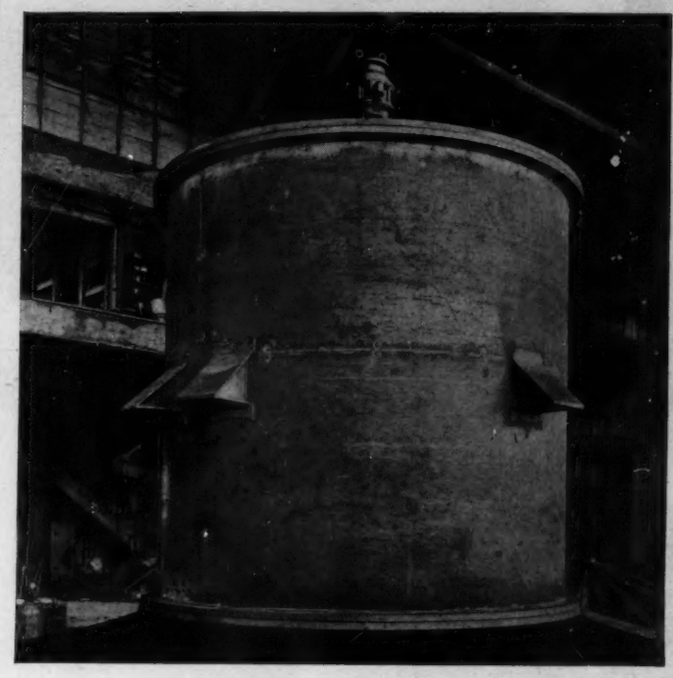
"Welds with your Uranium Electrodes were more homogeneous and resistant to corrosion than are ordinary welds"

BECAUSE of their proven superior qualities as indicated in the accompanying letter, the Portland (Ore.) Gas & Coke Company specifies.

Quasi-Arc Electrodes

for repair and replacement work.

Wherever welds of great strength, with high resistance to corrosion and with high immunity to fatigue from impact and torsional vibrational stresses are essential, work done with Quasi-Arc Electrodes will be found superior.



PORTLAND GAS & COKE COMPANY

PUBLIC SERVICE BUILDING

PORTLAND, OREGON

Quasi-Arc Incorporated
11 West 42nd Street,
New York, N. Y.

July 25, 1929

No. 1438 Attention: Mr. H. S. Ayres

Gentlemen:

In reply to your letter of July 19th, we have no objection to the use of the photos of our agitator in connection with the name of our company in your advertising.

The agitator is used in the process of refining benzol and toluol for motor fuel purposes and the rubber and paint industries. The crude light oil is washed with concentrated Sulphuric Acid which is followed by Caustic Soda solution. An agitator with seams welded with bare wire electrodes, after five years service shows the weld metal entirely corroded away from the inside seams of the agitator shell.

Laboratory tests indicated that welds with your Uranium electrode were more homogeneous and resistant to corrosion than ordinary welds, which led us to decide on the use of Uranium rods in welding the new agitator. In fact we are, wherever conditions to which our apparatus is subjected are corrosive, making repairs and replacements with Quasi-Arc welded material.

Yours very truly,

Portland Gas & Coke Company

E. E. HALL

General Superintendent.

Then there is the further advantage of saving in time, labor, material and money. The labor saving runs from 30 to 50 per cent, and there is less dependence upon the skill of the operator. As the weld metal from Quasi-Arc Electrodes is stronger, a smaller and quicker placed deposit is justified, and the strength is so uniform that calculation of the performance of the weld can be accurate and dependable.

That Quasi-Arc Electrodes will give you better welds at lower costs has been proven throughout the world by records of efficiency and economy which cannot be questioned. These records together with other convincing proof will be submitted to you by Quasi-Arc Service Engineers.

Quasi-Arc Electrodes are supplied in various diameters and in pure metal or alloy compositions. They are equally advantageous on new construction or small repair work, and are often the only means for meeting strict specifications on important jobs.

If you are not already thoroughly posted on Quasi-Arc Electrodes and their distinct superiority, you are overlooking one of the greatest opportunities in the welding industry.

Let us put before you the full details. Give us information as to the type of work you are doing and we will send data of successful performance on jobs of similiar character.

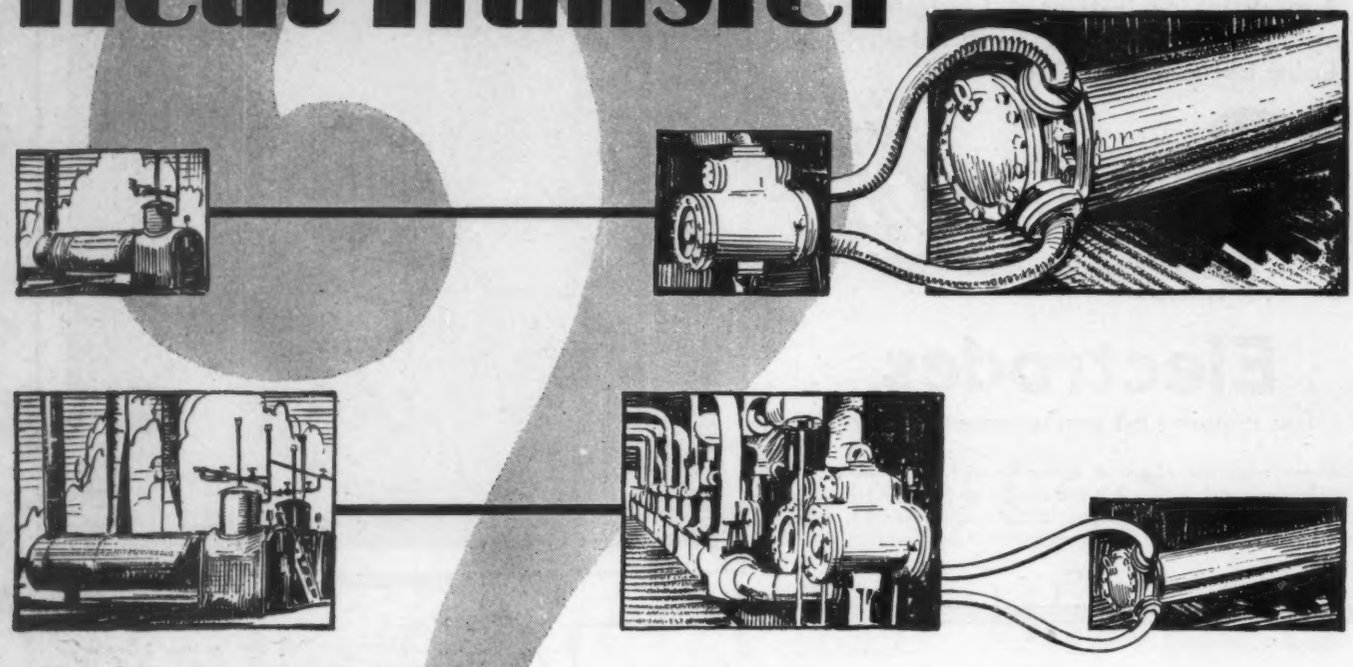
QUASI-ARC

Incorporated

11 West 42nd Street, New York, N. Y.

CHICAGO CLEVELAND TULSA LOS ANGELES

What Price Heat Transfer



New Heat Exchange Catalog is now ready for distribution. Copies sent upon request.

IN heat exchangers the transfer of heat varies almost directly with the oil velocity. The required heating surface for a given exchanger problem, therefore, is a function of the velocity of the oil. The actual cost of obtaining this velocity in pumping the oil through an exchanger varies with the efficiency of the steam generating and pumping equipment.

In designing heat exchangers for a given heat recovery it is, therefore, essential to determine a proper economic balance between: first cost of exchangers, and, first cost combined with operating charges of the pumping equipment.

The Foster Wheeler Corporation is particularly well fitted to solve this problem correctly for every refinery. Years of experience in the designing and building of heat exchangers and in the manufacture of complete distillation units provides a wide knowledge of the requirements.

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The installation consists of one thermometer to record temperature of discharge gas, and three Pressure-Vacuum Gauges to record intake, intermediate and high pressures.

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ARE widely used for all types of cooling and condensing service. Their automatic scale-shedding feature, high salvage value, flexible capacity, interchangeability, and long life are some of the many advantages that have made them popular in natural gasoline plants and refineries.

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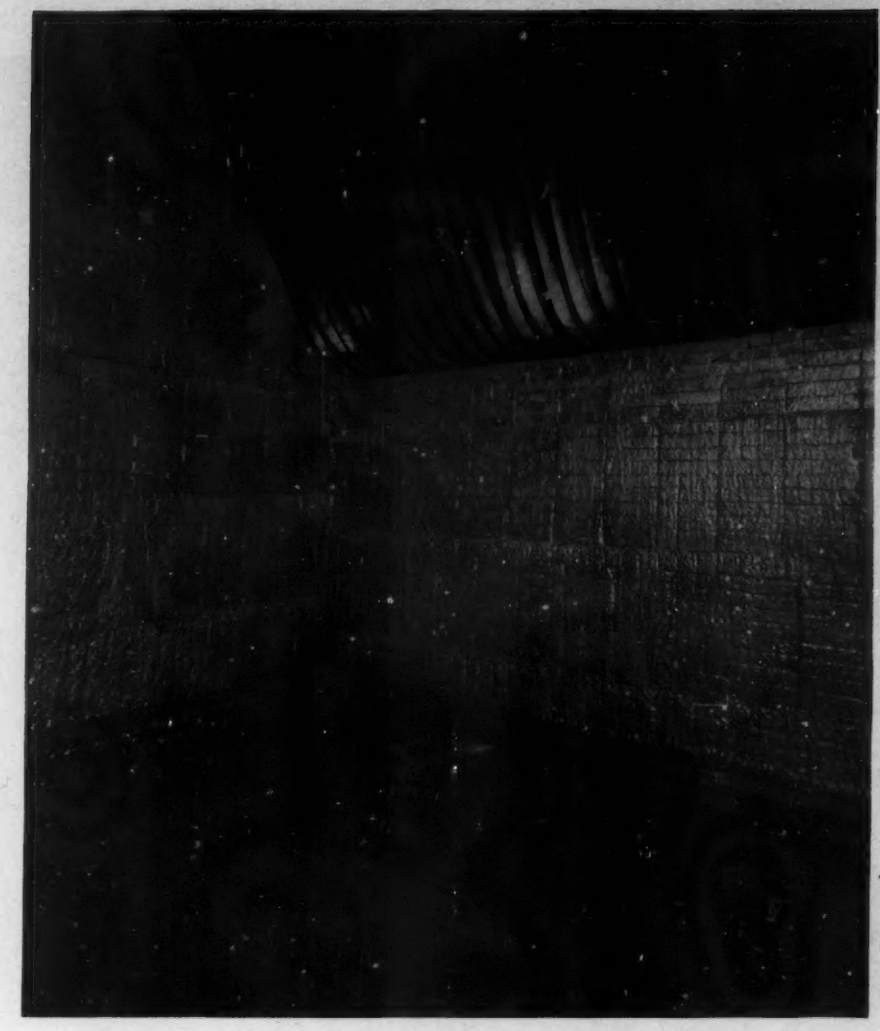
What Cracking Did for Gasoline

Detrick Has Done for the Refractory



Sectional-supported, air-cooled wall in high capacity oil-burning unit as installed by M. H. Detrick Co., 140 Dearborn St., Chicago. Detrick engineers are located at 50 Church St., New York; Murphy Bldg., Detroit; Empire Bldg., Pittsburgh; Russ Bldg., San Francisco, and in other principal cities

Threatened with extinction through the sheer increase in size and weight of furnace walls in huge modern power plants, the refractory wall has Detrick engineering to thank for a position even more secure and well defined now than ever before.

Just as the development of cracking processes removed limitations threatening the future of the gasoline engine, so has Detrick's development of new supporting and air-cooling principles minimized dangers of erosion, softening, spalling, fluxing and expansion which were rapidly putting refractory walls into the discard.

As a result, while the obviously valuable properties of water walls are creating a profound respect in the field of high-capacity, high-load-factor installations, Detrick Air-Cooled Walls and Arches are carving out an equal dominance in the lower-capacity, low-load-factor field and are *very* successfully meeting all requirements in installations even as high as 300,000 lbs. per hour per unit.

Detrick construction, permitting the easy shaping of concave and convex surfaces, with radial corners, reduces and all but eliminates erosion through use of the stream-line principle.

Softening of lower courses of tile under cumulative weight of the entire wall above is done away with by the Detrick method of dividing the wall into short horizontal sections, each independently supported from outside steelwork.

Spalling, the result of expansion and contraction, is also negligible in Detrick installations, even under such extremes of alternate heating and cooling as are especially demonstrated in modern cracking stills of the petroleum industry. Detrick sections, one tile wide and only 30 inches high, afford *each* tile an independent movement.

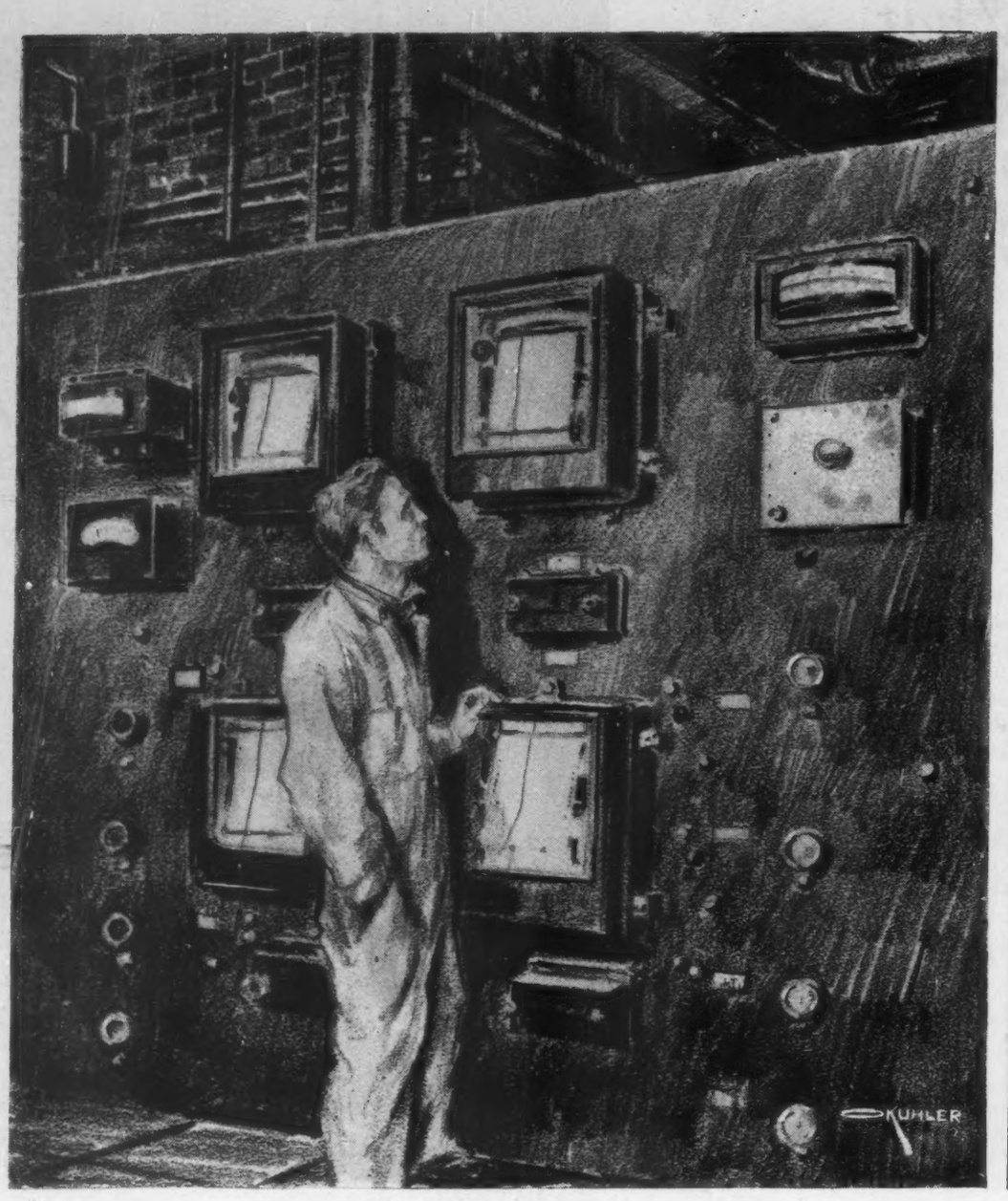
Fluxing and melting, as well as any disposition to soften or spall, are corrected by the Detrick air-cooling principle. Heat is conducted rapidly from the *interior* of each tile by the finned, cast-iron hanger which supports it. Correctly designed and proportioned air passages between the refractory and an outer wall not only bear away the excess heat but salvage it for useful work in primary or secondary air.

The Detrick sectional - supported principle insures (1) relatively low first cost, (2) simple erection, (3) long life under continuous operation, (4) easy repair and (5) flexibility in combining the air-cooling feature with efficient handling of the furnace air supply.

Thanks, therefore, to Detrick's revolutionary advances in the basic conception of furnace design, the refractory wall and arch are more than keeping pace with the upward trend in boiler size and rating. The power plant engineer who plans for *dollar efficiency* cannot afford to overlook the help a Detrick engineer nearby can give him.

DETRICK ARCHES & WALLS

"Better than the Refractory of which They are Made"



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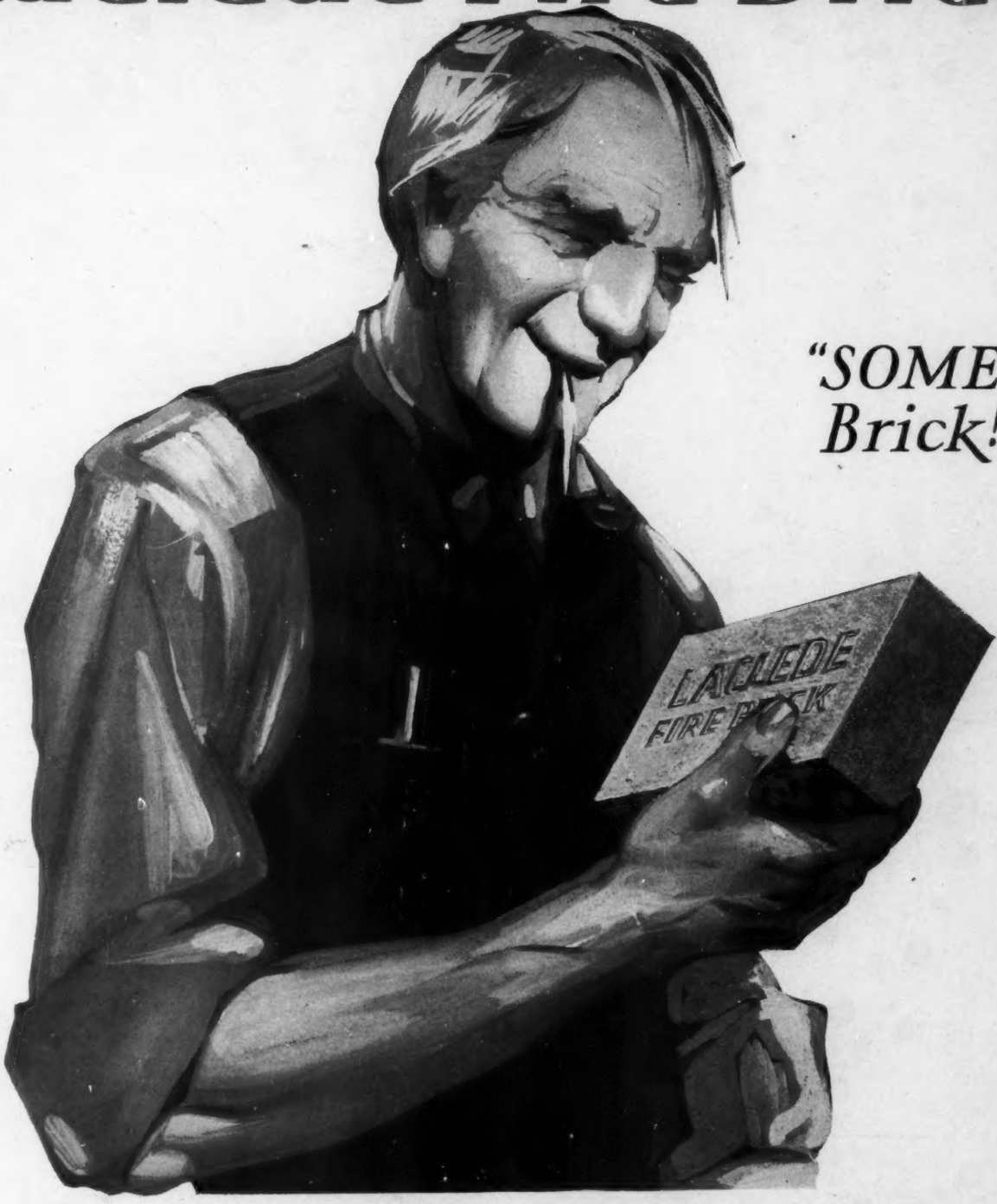

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